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Quality Preferences for Wheat and Wheat Flour:  
Noodle Wheat Markets in Japan and South Korea

By

Renee Boyoung Kim



A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment  
of the requirement of the degree of Doctor of Philosophy

in

Agricultural Economics

Department of Rural Economy

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Spring 2001



**University of Alberta**

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Quality Preferences for Wheat and Wheat Flour: Noodle Wheat Markets in Japan and South Korea" in partial fulfillment of the requirements of the degree of Doctor of Philosophy in Agricultural Economics.

OCT. 30 '00



## **ABSTRACT**

The quality characteristics of wheat and flour for noodle processing are important to Japanese and Korean millers in making purchasing decisions of imported wheat. This study focuses on improving knowledge about these quality characteristics. Multinomial logit models (MNL) were developed for each market to examine the preferences of Japanese and Korean millers on quality characteristics of wheat and flour. Survey data was collected using stated preference method (SPM) for both Japanese and Korean milling industries. In the evaluation of the Korean milling industry, an alternative method, called semantic differential scale (SDS), was also employed to derive millers' preferences on wheat and flour quality.

The parameter estimates of the MNL models are used to generate profiles of each wheat type and noodle flour product preferred by Korean and Japanese millers. These are compared to characteristics of wheat currently exported to Japan and South Korea by the three major exporting nations. This suggests that US wheat caters best to millers' preferences in the soft wheat market segments in the South Korean market, while US wheat caters best to millers' preferences in the hard and semi-hard wheat market segments in Japanese market. Australian wheat is found to cater best to millers' preferences for the medium class of wheat both in Japan and South Korea. Millers both in Japan and South Korea prefer wheat of Australian origin for medium and semi-hard wheats. For soft wheat, the US is the preferred source in South Korea. In Japan, the US is the preferred source for hard wheat. The results of the SDS analysis confirmed the SPM results for the Korean market.



The marginal effect of changes in factor levels on the probability of choices by millers is calculated based on the estimated coefficients from the MNL models. Results suggest that Korean millers are more responsive than Japanese millers to changes in the levels of quality factors of wheat and flour. Korean millers are also found to be more stringent in the quality specifications that they apply in purchasing wheat. These findings suggest that wheat-exporting nations may need to develop differentiated programs of product development for wheat sales to Japan and South Korea.



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# 1. INTRODUCTION

## 1.1 BACKGROUND

Japan and South Korea are the two largest wheat-importing nations in Asia, importing an average of 6.5 MMT and 3.46 MMT of wheat, respectively in the period from 1996 to 1998. The wheat-processing sector in both Japan and South Korea depends heavily on supplies of imported wheat, since there is no domestic production of wheat in South Korea and only 10 percent approximately of wheat consumption in Japan is supplied domestically. A significant proportion of wheat is consumed in the forms of noodles in both countries. For instance, noodle consumption made up 50 percent of total wheat flour usage during the time period from 1994 to 1999 in South Korea (USDA KS8028, 1998). In Japan, 27 percent of wheat flour usage was consumed as noodles during the period from 1996 to 1999 in Japan (USDA JA 0028, 2000). Thus, noodle markets are of importance in both South Korea and Japan to the derived demand for wheat flour. Demand for wheat used in noodle-processing plays a significant role in determining the demand for wheat in both nations.

There are fundamental differences in the wheat marketing systems of Japan and South Korea. The importation of wheat was privatized in South Korea in 1990 (KOFMIA, 2000). However, wheat importation in Japan is operated by a central buying agency, the Japan Food Agency (JFA), in Japan. Even so, Japan is currently implementing new wheat and barley marketing policies to reform its domestic wheat production and its milling sectors. The shift toward privatization of wheat marketing systems in both Japan and South Korea heightens competition among millers in each market and focuses attention on quality attributes of wheat and flour. The potential for wheat quality to be a competitive factor depends both on differences among competitor's supplies of wheat exhibiting various characteristics and on the demands for particular characteristics by importers (Wilson and Todd, 1993). There is increasing interest among wheat exporting nations for a more comprehensive understanding of the demand by Japanese and South Korean wheat buyers and millers. Information on millers' preferences for quality characteristics of wheat and wheat flour for the noodle market become increasingly important product development and marketing strategies by major exporting nations. Knowledge of such information is important to production decisions by exporting nations since the quality attributes of wheat have implications for wheat grading systems and for their plant breeding and wheat variety development programs.

## 1.2 PROBLEM STATEMENT

Traditional approaches to the analysis of import demand in the international wheat market typically use aggregate secondary data (Henning 1986, Agriculture Canada 1987, Lee, Koo, and Krause 1994, Schmizt and Wahl 1998, Wilson and Gallagher 1990, and Mao et al. 1997). These aggregate data are often averaged across price, origins, classes and grades. Consequently, information from these studies provides few insights into the impacts of quality on international wheat trading. More recently, heterogeneity of wheat classes has been recognized and evaluated in the context of the hedonic price analyses (Stanmore and Esfahani 1994a, Stanmore and Esfahani 1994b, Larue 1991,



Wilson 1989 and Veeman 1987). However, even these studies have problems associated with aggregation of secondary data on price and quality characteristics. These have sometimes resulted in different conclusions from different studies. Inconsistency in the results from hedonic studies regarding the implicit values of wheat quality characteristics can be also attributed to the frequency of data, time period under consideration and model specification.

The demand for wheat flour is extensively differentiated by the end-uses in the Korean and Japanese markets. The different end-uses for wheat flour lead to demand for various quality characteristics in wheat. Therefore, highly specific data, which are differentiated by market segment, wheat type and end-uses, are required to assess the preferences of Japanese and Korean millers on wheat and flour quality characteristics. The research problem of this study is to gather and analyze primary data on Japanese and Korean millers' preferences for wheat and flour quality characteristics used for producing noodles. The quality attributes of wheat are important in Asian buyers' decisions. It has been noted that there are financial rewards for achieving satisfactory quality levels since this enables exporters to market their wheat in higher priced markets (Stanmore and Esfahani, 1994a).

### **1.3 OBJECTIVES OF THE STUDY**

The overall objective of this study is to evaluate the demand for wheat and wheat flour for the noodle market sectors in Japan and South Korea.

The specific objectives of the study are to:

1. Generate primary data on millers' preferences for wheat and flour quality characteristics for the noodle market segment in both Japan and South Korea,
2. Assess the potential impact of product origin on millers' purchasing decision,
3. Examine the effect of the organization of the wheat marketing system on millers' choice behavior, and
4. Identify the most preferred product profiles for each wheat class and flour products in Japan and South Korea.
5. Compare the preferred profiles of three wheat classes in each market with the wheat that are currently offered by three exporting nations: the U.S., Australia and Canada. This will enable assessment of competitiveness of each exporting nation in terms of contract specification of wheat they are exporting.

### **1.4 HYPOTHESES OF THE STUDY**

Currently, Japan and South Korea have different wheat import regimes. Japan has a central wheat trading authority, called the Japan Food Agency (JFA), while South Korea has had a private wheat marketing system since 1990. Differences in the wheat marketing system in these two countries may allow inferences to be made about the effect of the organization of the marketing system on demand for quality attributes of wheat. As a market privatizes, millers are allowed to purchase directly from wheat exporters. Private buyers (millers) may demand more stringent and comprehensive specifications in their purchase contracts and that private buyers may be more responsive to changes in the quality specifications of wheat. Private buyers have a greater incentive to evaluate the



contribution of wheat quality to enhanced profits (Bruce and Wilson, 2000). Following this suggestion, general hypotheses of this study are that Korean millers may have more stringent and specific contract specifications for wheat importation than is the case of Japanese millers. Korean miller may be more responsive to improvements in the quality of wheat and flour for the noodle market. Information derived from examining this hypothesis could be relevant to wheat exporters and their efforts in developing differentiated marketing programs for Japan and South Korea.

### **1.5 RELEVANCE OF THE STUDY**

The study provides information on the quality characteristics of wheat and wheat flour that are preferred by Japanese and South Korean millers for noodle processing. From the exporters' perspective, understanding of this information should aid in developing effective and successful market development programs. This may not only facilitate export orientation but also have significant implications for the efficiency of the grading system, breeding programs and pricing practices for wheat in exporting nations.

Among the several previous economic studies conducted on the Asian wheat import markets, this study is the first to:

- (i) conduct a survey study on Japanese and South Korean millers' quality preferences for wheat and wheat flour, and
- (ii) focus specifically on the noodle market segment in these countries.

In most previous studies of wheat demand for South Korea and Japan, secondary price and quantity data have been used to evaluate these markets. This may be due to limited access to market information and extensive regulation by the government. Since the Government of Japan sponsored this study, potential difficulties in establishing contacts in the Japanese market were reduced. The wheat marketing system in South Korea was privatized in 1990, while Japan has been reforming some of its wheat marketing and trading policies since 1997. Uncertainty and changes in the milling sector in Japan and South Korea increased millers' willingness to participate in the survey interviews and to document current conditions of wheat marketing in each country. Comprehensive information on standards and preference for wheat and wheat flour quality characteristics, particularly for wheat for noodles, will benefit potential buyers and sellers, and improve efficiency in international trading of wheat.

### **1.6 METHOD OF THE STUDY**

The main purpose of this study is to generate and evaluate current information on the nature of these markets and preferences of Japanese and Korean millers. Survey-based data from these markets were collected. The survey and interview of Korean and Japanese millers were conducted during the period from November of 1998 to December of 1999 in South Korea and Japan.

The survey was applied in two time periods. The first period involved pre-survey interviews with the millers and other key informants in both Japan and South Korea. The second period consisted of formal survey interviews. In the preliminary meetings, key informants in the milling sector were identified and contacted. Current issues of interest



and concern regarding these industries (including wheat quality issues) of the milling sector were discussed. Based on the information obtained from the pre-survey interview, a formal questionnaire was developed for each market. In the second stage of the survey process, the millers were interviewed with the formal survey questionnaire.

The Canadian Wheat Board (CWB) Tokyo office, the Canadian Embassy in Japan and the Department of Economics in Niigata University in Japan participated in making contacts with Japanese millers in conducting the survey sessions. The Canadian Embassy in South Korea, together with the Korea Flour Millers Association (KOFMIA), assisted in making contacts with Korean millers.

Information from the pre-survey interviews with key informants in the Japanese and South Korean milling sectors are used as the basis of the section on background information given in Chapter 2. Comments and opinions expressed by the respondents are cited as interview information. Information derived from the pre-survey interviews provides insight into the structure and conduct that applies in both these markets.

### **1.7 OUTLINE OF THE THESIS**

The thesis is presented as follows: the second chapter begins with a discussion of the wheat market and the noodle market in Japan and South Korea and the wheat marketing systems in these nations. The third chapter provides the theoretical background and literature review for developing a model to estimate millers' quality preferences. The fourth chapter describes methodology used in data collection and the process of the survey. The fifth chapter employs the proposed model and derives empirical results based on interviews with millers in the Korean market. The sixth chapter presents empirical results relating to the Japanese market. In the seventh chapter, quality preferences of Japanese and Korean millers are compared using the empirical models from Chapters 5 and 6. Marketing and policy implications for each market are drawn in Chapter 7 based on the results from the preceding analyses. The final chapter provides discussions, conclusions and recommendations relating to future research.



## **2. THE JAPANESE AND KOREAN WHEAT AND NOODLE MARKETS**

### **2.1 INTRODUCTION**

In order to develop an empirical model to evaluate the quality characteristics of imported wheat and wheat flour in Japan and South Korea, it is necessary to review these markets. This chapter explores important characteristics of Korean and Japanese wheat sectors and notes historical changes that have affected their wheat marketing systems. Special attention is paid to the wheat market for noodles in Japan and South Korea. The discussion outlines recent changes in economic conditions in South Korea, wheat-marketing policies and the structure of the wheat marketing system in both nations. The marketing strategies implemented both in Japan and South Korea by three major exporting nations-the U.S., Canada and Australia are also noted.

### **2.2 SOUTH KOREAN WHEAT MARKET**

According to Koo and Taylor (1999), Asian imports of wheat are projected to increase by 22.1% between 1998 and 2008. Imports by Japan and South Korea are projected to increase 8.0% and 25.9%, respectively, for the 1998-2008 period (Table 2.1). South Korea is the second largest wheat buyer in Asia, importing an average 3.46 MMT of wheat per annum for the 1996-98 period (Table 2.1). More importantly, the Korean wheat market is entirely dependent on import supplies and exhibits increasing demand for wheat-based food products. This section discusses the demand for wheat and wheat flour, the consumption of wheat flour based products and factors that contribute to the growth and changes in the Korean market.

#### ***2.2.1 Demand for Wheat and Wheat Flour in South Korea***

There was an upsurge in wheat flour consumption in 1988 in Korea that has been attributed to the Seoul Olympics. Korean per capita consumption of wheat flour reached a record level of 40.0 kg in 1988 (Table 2.2). Per capita flour consumption fell following 1988 and consumption stayed at about 33.0 kg during the period from 1990 to 1995. However, an upward trend in the consumption of wheat flour in the form of noodles persisted through the 1980s and noodle consumption accounted for 50 percent of total flour consumption in 1998 (see KOFMIA 1999 and Figure 2.1). Bread, cake, and cookies accounted for 20 percent of total flour consumption through the 1980s and 1990s (Figure 2.1).

A number of factors may have contributed to the growth and changes in the composition of the consumption of wheat flour in South Korea. The Korean economy continued to grow over the past two decades, and this seems to have considerably influenced Korean dietary patterns (Table 2.2). Per capita gross national product (GNP) was US\$1,597 in 1980 and increased to US\$4,295 in 1988. Although South Korea underwent a severe financial crisis in the period from 1997 to 1998, the economy recovered relatively quickly. For instance, the growth rate of gross domestic product (GDP) in South Korea was 10.7 percent in 1999 relative to 1998 (Table 2.2). Due to the rapid growth in the economy and the increase in individual incomes, the South Korean diet has become more



westernized and the consumption of wheat-based food products has increased substantially (Table 2.2).

The number of females participating in the work force continued to increase from 1980 to 1999 so that 48.3 percent of the total female population participated in the work force in 1999 (Table 2.2). As the female work force participation increases, eat-away from home and convenience food items, which are based on wheat flour, tend to become more popular. Reflecting this, home use of wheat flour showed a downward trend during early 1980s and reached almost zero percent in 1988.

Increase in the derived demand for instant noodles is another factor contributing to the increase in the wheat flour consumption. Instant noodle consumption in South Korea increased significantly between 1982 and 1995 (Figure 2.1). Consumption of wheat flour in the form of noodles has increased from 23.6 percent of total flour consumption in 1981 to 50 percent in 1998 in South Korea (KOFMIA, 1999). Total annual per capita consumption of instant noodles in South Korea was estimated to be about 83.4 servings between 1988 and 1998, which is one of the highest consumption levels in the world (Samyang, 1999). In comparison, Japanese consumers accounted for about 39 servings per year in the same time period. An increase in demand for noodles in South Korea has also arisen from a rapid increase in overseas demand for Korean produced instant noodles (USDA KS 8028, 1998b). For example, Korean instant noodle exports jumped to 27,841 metric tonnes (MT) valued at US\$61 million in 1994 from 20,285 MT valued at US\$43 million in 1993 (Voboril et al, 1995). The significance of the noodle market has implications for wheat exporters in determining the characteristics of wheat and flour that are preferred in South Korea.

### ***2.2.2 The Noodle Market in South Korea***

Three major types of noodles in South Korean noodle market are dry noodles, Udon noodles and instant noodles. Instant (fried) noodles are called “Ramen” in South Korea, while in Japan, Ramen represent instant (fried) Chinese noodles. In Japan, there are two sub-categories for Chinese noodles: fresh noodles and instant noodles (Bingrae, 1999). In summary, Udon, dry noodles and Ramen are the major noodle categories in South Korea, while Udon, dry noodles, fresh Chinese noodles and Ramen are the major noodle categories in Japan.

The Korean Ramen market segment has the largest market share at approximately 80 percent of the noodle market, while the other two noodle categories each represent 10 percent of the remaining market share (KOFMIA, 1999). The market segment for Ramen in South Korea can be sub-classified into two types of Ramen products: Ramen sold in the form of cup and Ramen sold in the form of bag. The growth rates were reported to be 6.1 percent for the bag type Ramen market and 6.4 percent for the cup type Ramen market in 1999 (Bingrae Co, Ltd.). Based on the packaging method, Ramen for the bag type noodle market can be further classified into two types: high-quality bag noodles (highly priced) and common-quality bag noodles.



Figure 2.2 shows that the sales volume of common-type instant noodles grew slowly over the past decade, while the demand for high-quality bag and cup noodles have each doubled during the same period. For instance, the market share of the common-type Ramen noodle decreased from 78.7 percent in 1985 to 37.0 percent in 1990. The Bingrae report (1999) projected that demand for the high quality bag and the cup noodles will further increase, while common-quality bag noodle consumption will decrease.

Despite the economic setback during the financial crisis in the period of 1997-98, domestic sales of Ramen noodles totaled US\$0.66 billion in 1997, an increase of 8.5 percent over 1996 (Choi and Henney, 1998). For the same period, Korea's international noodle sales totaled US\$115 million. The Ramen market in South Korea has shown strong growth. This noodle product is now a staple in the daily diet of consumers in South Korea.

There are five Ramen manufacturers in South Korea. Nongshim is the largest manufacturer in this market with 63.3 percent market share, followed by Samyang with 13.7 percent market share. Ottogi, Yakurutu and Bingrae have 10.5, 8.4 and 4.1 percent market shares, respectively (SAMYANG, 1999). According to the report of Samyang (1999), manufacturers in the Korean Ramen market compete through product differentiation and new product development. The report also states that since the Ramen market is the largest user of wheat flour in South Korea, millers produce their wheat flour products according to the preferences of the Ramen manufacturers. In developing new Ramen products, the millers and the Ramen manufacturers conduct joint research on wheat flour milling and Ramen processing. Hence, quality specifications for wheat flour are becoming much more specific and stringent among the Ramen manufacturers, and this influences millers' purchase of wheat significantly (Interview, 1999). The cup Ramen market is expected to grow since the main consumer of Ramen are the young people who have preferences for convenience (SAMYANG, 1999).

The Samyang report notes that there is a trend of increasing health consciousness by the consumer. This increases the demand for fresh noodles since fresh noodles are perceived to be healthier than Ramen noodles. The fresh noodle category includes three sub-classes. They are long life (LL) noodle; short life (SL) noodle and frozen noodle (Interview, 2000). The original fresh noodle includes four stages of processing: mixing, compressing, sheeting and packaging. However, this form of noodle has a shelf life of only three days due to its high moisture content. The LL, SL and frozen noodle products are developed to extend the shelf life of fresh noodle products. The LL noodle includes two additional processing stages, boiling and sterilization, before packaging and has three to five months of shelf life. The SL noodle includes one additional processing stage, boiling, before packaging. This product has one week of shelf life. The processing procedure for frozen noodles is the same as for fresh noodles, but this product is stored at temperatures less than -15 Celsius degrees. Its shelf life is between five to nine months (SAMYANG, 1999).

In the past, the Korean noodle market could not readily supply fresh noodles due to a lack of the infrastructure that is necessary for its marketing (Interview, 2000). Recently, there has been an improvement in the cold-chain storage system that coordinates efficient



transportation of fresh noodle products (Interview, 2000). The fresh noodle market segment accounts for 10 percent of the total noodle market in Korea. Although the fresh noodle market and the dry noodle market represent an equivalent proportion (10%) each of Korean noodle demand, the fresh noodle market has been projected to grow more rapidly, as consumers prefer the convenience, health and functionality of fresh noodles (Samyang, 1999).

Industry observations are that the Korean Ramen market has peaked in volume and that growth in this market is changing from an expansion of sales volumes to quality improvement of Ramen products. Quality competition among Ramen manufacturers is projected to translate into marketing of high price, premium Ramen products, extensive product differentiation and improvements in the aesthetic and functional aspects of packaging. Also, there is viewed to be potential for expansion of the market segment of fresh noodles and growth in cup type Ramen due to demand for convenience (Samyang, 1999).

## **2.3 JAPANESE WHEAT MARKET**

Japan is currently the largest wheat importer in Asia, importing an average 6.2 MMT annually in the period from 1996 to 1998 (Table 2.1). Japan's wheat importation is projected to increase to 6.5MMT by 2008 (Table 2.1). Domestically produced wheat supplies 15 percent of total wheat consumption and imported wheat supplies the balance of this. Wheat and flour demand in Japan is highly differentiated by end-use (Interview, 1999). This section outlines features of the demand for wheat and wheat flour in Japan and notes the composition of the consumption of wheat flour.

### ***2.3.1 Wheat and Wheat Flour Demand in Japan***

The Japan Food Agency (JFA) has identified the Japanese instant noodle industry as a growth market, while the bakery and bread industries in Japan are viewed as more of a "zero-sum" market (Table 2.3 and Table 2.4). The Japanese instant noodle industry grew at 1.8 percent and 3.3 percent in 1995 and 1996, respectively, while the total growth rate of Japanese bread production over the last four years has been near zero percent (JFA, 1997).

Industry participants believe that changes in the composition of wheat flour consumption in Japan can be explained by two factors. Japan's economy grew rapidly to 1985 when per capita GDP was at US\$ 11,282. By 1995, per capita GDP in Japan was US\$41,075 (ESCAP, 2000). Concurrently, the dietary pattern of Japanese consumers has westernized during the early 1980s. However, due to the economic recession in Japan in the late 1990s, consumption of western dishes at upscale restaurants had decreased, while consumption of noodles in low priced noodle shops has become increasingly popular among Japanese consumers. This contributed to the increase in the consumption of wheat flour in the form of noodles (Interview, 2000).

Changes in demographics also contributed to recent changes in the composition of wheat flour consumption. While the growth rate of the total population continually decreased during the period of 1980-1997, the population demographics changed during this period.



The age group that ranges from 15 year olds to 64 year olds increased from 67.3 percent in 1980 to 69.0 percent in 1997, while the age group from infants to 14 year olds decreased from 23.5 percent to 15.3 percent (Table 2.5). The Bingrae report (1999) indicated that approximately 85.8 percent of the Japanese population eat instant noodles, and the main consumer group includes younger generation Japanese aged from 12 to 25 years. Consequently, increases in the age group that include 15 to 64 year olds may raise the consumption of instant noodles. Also, female labor force participation increased from 38.7 percent of total female population in 1980 to 40.7 percent in 1997. As the female labor force participation increases, the convenience and functionality of instant noodles becomes increasingly valuable. Thus, the increase in the female labor force is expected to contribute further to the increase in the consumption of instant noodles in Japan.

To produce different wheat flours, Japanese millers use different wheat specifications and different blending formulae. Each miller blends different wheat classes using different formulae to differentiate their products. As market competition intensifies and the Japan food agency (JFA) reduces its subsidy to the millers, individual millers are expected to continue to develop and improve new blending formulae for the production of wheat flour (Interview, 1999). Product differentiation in wheat flour products is expected to continue to increase in Japan.

### ***2.3.2 The Noodle Market in Japan***

In Japan, different types of wheat flour are categorized based on different types of noodles. Based on the form of noodle, there are four main categories of noodle products in Japan. These are fresh Chinese noodles, fried Chinese noodles (instant noodles called “Ramen”), dry noodles and Udon noodles. Thus four types of wheat flour are used to make the four different types of noodle products. Among these four types of noodles, Udon noodle accounts for 35 percent of total noodle consumption, followed by instant noodles with 20 percent market share (JFA, 1999).

A Tradescope report (1994) presented a comprehensive overview of Japan’s noodle market at that time. The report states that the demand for dried noodles stagnated in the 1980s, due to the increasing reluctance of the consumer to spend time to boil dry noodles. Dry noodles were viewed to have an old-fashioned image, which was also believed to contribute to the lack of growth in this noodle market segment. On the other hand, the demand for fresh noodles was reported to have increased due to their convenience in preparation. Consumption of frozen noodles and the long life (LL) noodles had been growing rapidly. The report indicated that frozen noodles are largely consumed by the food service industry in Japan due to: (1) ease of preparation; (2) the small cooking space required; (3) the storability and the lack of waste, and (4) the simple cooking instruction. Frozen noodles are prepared by quick-freezing noodles immediately after these are boiled so there is no loss of flavor and a high level of quality for final product can be maintained over a long period. The demand for fresh noodles is expected to continue growing for the restaurant market segment.

There are six large instant noodle manufacturers in Japan. These account for 90 percent of the instant noodle market. Industry representatives report considerable cost



competition and low profit margins in this industry so that this business environment requires an instant noodle manufacturer to have large-scale production and to engage in continuous product development (Interview, 2000).

The demand for noodles in Japan is more diverse than in South Korea. While the instant noodle (Ramen) market segment has only 20 percent market share in Japan, the fresh-type Chinese noodle market segment has been growing rapidly. For instance, in 1996 the annual volume of wheat flour used for fresh Chinese noodles was 724,800 MT, while the wheat flour usage for dried noodles and instant noodles was 259,300 MT and 324,300 MT, respectively, in 1996 (Table 2.6). Fresh Chinese noodles are moist, giving a fresh image, and produce a flavor close to that of regular noodles (Tradescope, 1994). The freshness of fresh Chinese noodles relative to instant (fried) noodles and the increasing interest for health which is associated with the freshness are claimed to be the main factors contributing to the considerable growth in the demand for fresh-type Chinese noodles (Interview, 1999).

## **2.4 THE WHEAT MARKETING SYSTEMS IN JAPAN AND SOUTH KOREA**

Although Japan and South Korea are both heavily dependent on importation for supplies of wheat and each imports similar types of wheat from the same exporting nations, there are fundamental differences in the wheat trading systems of these two nations. The importation of wheat is currently regulated by the Japan Food Agency (JFA) in Japan, while the wheat marketing system has been privatized in South Korea since 1990. However, the Japanese government is shifting to a less rigid wheat marketing system by changing its wheat marketing policies. The following section discusses the privatization process of the Korean wheat trading system and the recent changes in the Japanese wheat trading system. The discussion also includes information on current features of the imported wheat market in both countries.

### ***2.4.1 Wheat Marketing System in South Korea***

Total annual wheat production in Korea is less than 1,000 MT, thus wheat supply is almost entirely dependent on imports. This is mainly due to an unsuitable climate for growing wheat and the lack of import protection affected domestic production of this crop. The South Korean government has traditionally been very protective of its agricultural industry. This protective agricultural policy can be explained by two factors. First, food security has always been an important issue to the South Korean people. The experience of severe famine in the post-World War II period together with scarcity of resources and potential threats from North Korea have reinforced the South Korean Government's perspective favoring food self-sufficiency for security. Second, rural communities in South Korea have substantial political power. The rural population elects over 50 percent of the National Assembly seats, although the rural population accounts for less than 25 percent of the total national population. Consequently, Korean farmers' interests have a significant influence on political parties' mandates, and the Korean government has supported protection of the domestic agricultural sector (Park et al. 1997).



A recent report by the Presidential Commission on Economic Restructuring recommended a "dual track" approach to the support of agriculture. The purpose of this approach is to continue the protection of production of essential staples such as rice, while relaxing trade restrictions on less important food items such as fruits and nuts in order to lower problems of trade frictions (Agricultural Coop Yearbook, 1996). The Korean government purchases about 15 to 20 percent of the domestic rice crop at highly subsidized prices, giving an incentive to South Korean farmers to concentrate on rice production. Wheat production is not defined as an essential staple and this is not subsidized in South Korea.

During the 1980s Korea exhibited continuing current account surpluses with the U.S.. These amounts were US\$ 7.3 billion, US\$ 9.6 billion, US\$ 8.6 billion in 1986, 1987 and 1988, respectively (ESCAP, 2000). The U.S. Government exerted strong pressure on the Korean Government to allow greater market access in order to improve the balance of trade. To avoid trade sanctions from the U.S., the Korean Government introduced trade import liberalization measures on selected products, and wheat was one of those items targeted (Agricultural Cooperative Yearbook, 1996).

The trade liberalization program for milling wheat imports was begun in 1983 and completed in 1990. For instance, the annual milling wheat import quota was set at 2.28 MT for 1989 and 2.3 MT for 1990 (KOFMIA, 1996). The liberalization of wheat importation in South Korea eliminated the fixed import quota of 2.3 MT in 1990 (KOFMIA, 1997). Following trade liberalization, South Korean millers have used two routes to import wheat. First, the millers can directly negotiate with exporters; second, wheat can be purchased by tender from the Korean Flour Mills Industrial Association (KOFMIA), formerly a central buying agency of the Korean Government.

As a result of the Uruguay Round (UR) negotiations, there have been significant institutional reforms in Korean wheat trade policy. From the outcome of the UR meetings:

“...Under the December 1993 Record Of Understanding (ROU), signed between the United States and Korea during the Uruguay Round (UR) negotiations, wheat was included in a list of products that shall be reduced by 40 percent from the duty level applied in 1993 and shall be bound at the reduced level. This reduction shall be implemented in ten equal installments, from 1995 to 2004. This would lead to a reduction of tariff rate on wheat from 1993 applied rate of 3 percent to 1.8 percent by 2004 with a rate of 2.64 percent in 1997...” (USDA, 1998 p6).

A 5 percent tariff (ad valorem) on wheat imports was maintained prior to 1995, but this is expected to decrease to 1.8 percent by 2004 (Table 2.7). The importation of wheat flour has occurred since 1989 at the tariff rate of 10 percent (ad valorem). The ROU of 1993 also specified a schedule of tariff reduction in importation of wheat flour (Table 2.8). A 5.0 percent tariff applies to the importation of wheat flour to South Korea in 2000 and this is scheduled to be reduced to 4.2 percent by the year 2004.



South Korean millers have had access to use GSM-102 provided by the U.S. as the major source of credit usage for importing wheat during the period of 1982-1989 (Interview, 1999). The GSM-102 is a credit guarantee offered by the U.S. government. The GSM-102 allows mills to repay their debt with a lower amount of Korean currency (Won) at the end of a credit term. The availability of GSM-102 gave an advantage to the South Korean millers when Korean Won appreciated in value against the US dollar during the mid to late-1980's. The exclusive use of U.S. credit (GSM-102) by South Korea was an obstacle to other wheat suppliers and allowed the U.S. to use this as an exclusionary marketing strategy (Interview, 1999).

However, the importance of credit usage in South Korea has diminished in the 1990's since the Korean Won has remained stable against the U.S. dollar. Thus South Korean millers have had less incentive to import U.S. wheat based on access to credit. Credit usage became a less critical factor in milling wheat importation until the financial crisis that occurred in 1997. The U.S. government has gradually decreased the GSM-102 allocation. The GSM-102 allocation was US\$ 155 million in 1993 and US \$ 97 million in 1995 (KOFMIA, 1997). In 1996, the South Korean government announced the termination of the GSM-102 credit on milling wheat effective October 1996. The elimination of the GSM-102 program for South Korea creates increasing market opportunities for other suppliers. However, the GSM-102 program was reapplied temporarily in 1997 when the financial crisis took place in South Korea in order to assist millers in purchasing imported wheat from the U.S.

#### ***2.4.2 Imported Wheat Market in South Korea***

Prior to the start of liberalization of wheat importation in 1983, South Korean millers were only allowed access to U.S. wheat (Table 2.8). U.S. dominance in the South Korean wheat market prior to 1983 is largely due to the close political and military relationship of the U.S. with the South Korean government. The first flour mills in Korea were set up in 1959 with donations of capital and wheat by the U.S. government (KOFMIA, 1997). As the Korean wheat market expanded rapidly and became lucrative, the U.S. implemented GSM-102 credit guarantees for South Korea in 1982. These covered 65 to 70 percent of the Korean milling wheat import requirements. During 1980s, this GSM-102 credit use was beneficial for both the U.S. and the Korean millers due to appreciation of the Korean Won. Thus, the financial situation in 1980s and early market development placed the U.S. in an advantageous position during the 1980s. However, the situation began to change in the late 1980s. As the use of GSM-102 credit became less important due to a stable Korean Won, the exclusive market position of the U.S. in the Korean wheat market declined (Table 2.8). The market share for wheat of the U.S. declined from 91 percent in 1986 to 68 percent in 1996.

Before 1983, millers were using three different U.S. wheat classes: Western White/ Soft White (WW/SW), Hard Red Winter (HRW) and Dark Northern Spring (DNS) (Table 2.9). Millers produced wheat flour for the noodle market by blending these three different U.S. wheat classes in different proportions (Shin Han, 1999). However, as the market opened in 1983, South Korean millers also began to purchase wheat from Australia and Canada (Table 2.8 and 2.9).



Over the past decade, the market share of U.S. wheat in the South Korean wheat market has gradually decreased while that of Australia has increased. Australia's market position has improved particularly since 1989. During the 1970s and the 1980s, Australian milling wheat exports to South Korea were sporadic, representing only about 2 percent market share on average, but starting in 1989, Australia's market share has increased. The Australian market share had grown to 31.6 percent by 1999, while the U.S. market share decreased to 64.2 percent in 1999 from 100 percent in 1983 (MAF, 1997). Canada, the third largest wheat exporter to South Korea, has 4.2 percent market share in this market. As Australia employed customized production contracts to make inroads into the noodle market, U.S. market share has steadily declined (Choi and Henney, 1998). According to USDA trade statistics (2000), the U.S. market share of total Korean wheat imports stood at 46.7 percent, Australia at 45.4 percent and Canada at 7.9 percent in 1999.

The U.S. currently exports three different wheat classes to South Korea: WW/SW, HRW and DNS. Canada exports to South Korea one type class of wheat, Canadian Western Red Spring (CWRS), with 13.5% protein content (KOFMIA, 1999). Currently Canada promotes CWRS at lower level of protein content. In 1999, Canada exported 7,950MT and 22,000 MT of CWRS at 11.5% and 12.5% of protein content, respectively, to South Korea as a trial case (KOFMIA, 1999). Australia markets five different wheat classes in South Korea: Australian Standard White (ASW), Australian Soft (AS), 100% Australian Noodle Wheat, Australian Prime Hard (APH) and Australian Hard (AH). Millers in South Korea categorize imported wheat into three categories: hard wheat, medium wheat and soft wheat, while millers in Japan divide imported wheat into four categories: hard wheat, semi-hard wheat, medium wheat and soft wheat. The hard wheat category from South Korea has similar quality specifications to the semi-hard wheat category in Japan. Since this study includes comparison of these two markets, the hard wheat category of South Korean market is described as “semi-hard” wheat to avoid confusion. The rest of this thesis uses the term “semi-hard wheat” to refer to the hard wheat category as specified in South Korea.

In South Korea, U.S. DNS, Canadian CWRS and Australian AH and APH fit in the semi-hard wheat category, while Australian ASW and U.S. HRW fit into the medium wheat category. The Soft wheat category includes WW/SW from the U.S. and AS from Australia. Millers use different wheat classes for production of flour for different purposes. Conventionally, Australian ASW and U.S. HRW wheat are known for the production of noodle flour among millers, and U.S. DNS and Canadian CWRS wheat are recognized for the production of bread flour in South Korea. Korean millers use ASW and AH wheat to produce flour for high quality Ramen noodle and use blends of HRW and WW to produce flour for ordinary quality Ramen noodle (Interview, 1999).

#### ***2.4.3 Wheat Marketing System in Japan***

The Japanese government is known for its protectionist policy toward the agricultural sector. The protective policy can be explained by two factors. First, the pursuit of food security through self-sufficiency policies has received very high national priority for many years in Japan. Second, there has been strong political pressure from



Japanese farmers to minimize income disparities between farm and non-farm households as rapid industrialization during the 1950s accentuated a continuing relative decline in income of the agricultural sector.

In 1942, the Food Staple Control Act was enacted in order to provide a stable domestic supply of cereal grains in Japan by promoting rice production and controlling wheat importation. This Act gave the JFA the exclusive right to directly control price and marketing of wheat, rice and barley to protect its agricultural sector. The JFA has managed dual marketing of domestic and imported wheat by implementing "Wheat and Barley Management Improvement Measures" since the latter half of the 1960s. It uses two instruments to protect the domestic agricultural sector, border protection measures and domestic subsidies. Border protection measures, by definition, are quantitative restrictions against imports. The quantity of wheat imported is set to "clear" the domestic market at the administered resale and producer prices (Murniningtyas and Love, 1992).

For domestic production of wheat, the JFA determines its plans for domestic wheat purchases each year in August and September in consultation with representatives of flour millers and domestic wheat producers. Once the domestic purchase plan is set, the JFA hold a semi-annual meeting with flour millers, bakers, noodle-makers and private grain traders to develop its wheat import plan. When the wheat import plan is finalized, the JFA annually sets a specific amount of import quota for three major wheat exporters--the U.S., Australia and Canada. U.S. private grain trading companies market wheat to Japan, while Australia and Canada have state-trading wheat exporting enterprises: the Australian Wheat Board (AWB) and Canadian Wheat Board (CWB). These STEs have an official annual meeting with the JFA relative to the determination of the amount of wheat to be exported to Japan.

The annual import quotas of the JFA are then allocated to licensed trading companies. The allocation to each importing company tends to preserve its market share from year to year (ABARE, 1988). Grain traders, licensed by the JFA, import wheat by class at world price under the aggregate import quota and tender the imported wheat to the JFA at their purchase price plus a mark-up reflecting ocean freight, insurance and carrying costs. There are approximately 30 trading companies with licenses to import wheat and the top five importing companies dominate the wheat import business. The top five companies handle 65 percent of imports (Interview, 1999). Exporters do not sell directly to the JFA, but negotiate with these designated trading companies. These companies, in turn, sell wheat (c.i.f.<sup>1</sup> Japan), to the JFA. The JFA discourages competition for market share by the designated trading companies by allocating constant quota shares to them. Thus this system does not reflect the lowest import prices. The JFA then resells the imported wheat to domestic millers at administered resale prices. Profits from this two-tier price mechanism have been used to subsidize the domestic agricultural sector.

While this pricing policy benefits Japanese wheat producers, it imposes substantial costs on Japanese millers, end-users and consumers which results in a misallocation of resources in the economy overall (ABARE, 1988). Japanese millers may pay prices that

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<sup>1</sup> C.i.f. represents cost, insurance and freight rate that are included in the price of traded wheat.



are three to five times higher than the world wheat price. Due to this policy, a decrease in world wheat prices does not directly affect Japanese producers nor does it benefit Japanese consumers. Because of fixed internal resale prices, gains to the JFA from a decline in world prices are substantial. Hence, the aggregate demand for wheat in Japan is quite stable, regardless of world wheat price fluctuations (Table 2.10).

The purpose of the two tier pricing policy is to discourage production of rice and to encourage the production of wheat and other crops (Riethmuller and Roe 1986). Iwaasa (1999) explained that this pricing system has an alternative function as a risk management tool used to avoid short-term negative effects caused by fluctuations in international market prices and foreign exchange rates. Iwaasa (1999) reported three factors that are considered by the JFA in setting resale price levels. Firstly, the JFA considers factors such as changes in the exchange rate, changes in imports of processed wheat and any changes in preferences by consumers and millers. Secondly, the JFA also considers trends in international wheat prices since this affects the JFA's profit margin from reselling imported wheat, used to cross-subsidize domestic wheat market. Thirdly, the relationship between the prices of wheat and rice is another important factor. One of the JFA's mandates is to balance the supply among food staples and to support domestic rice producers. The method of calculation of resale prices is reported to be excessively complex and subject to significant official discretion (Iwaasa, 1999). The purpose of the two-tier pricing system is to cover all of the JFA's losses in the purchase and sales of domestic wheat by the profits from the resale of imported wheat, and to cross-subsidize the rice sector.

#### ***2.4.4 Imported Wheat Market in Japan***

The import quota allocation by the JFA to the three major wheat exporting nations has been highly stable over the past three decades (Table 2.10). The U.S. holds 55 percent of the market share, while Australia has 23 percent and Canada has a 10 to 12 percent of the market share in Japan's imported wheat market on food wheat basis (Nitto Flour Ltd. Co., 2000). As noted previously in Section 2.4.2, the U.S. exports three different types of wheat classes to Japan: DNS, HRW, WW/SW, while Australia markets AH, APH, ASW and AS and Canada exports CWRS (Table 2.9). The JFA specifies four classes to categorize different wheat class: hard wheat, semi-hard wheat, medium wheat and soft wheat. U.S. DNS (14.0%) and Canadian 1CWRS (13.5%) fit into the hard wheat class, and U.S. HRW at two protein levels (13.0%) and (11.5%) fits into semi-hard wheat class. The class of medium wheat includes Australian ASW and Japanese soft wheat. The soft wheat class includes WW/SW from the U.S. (Nitto Flour Co. Ltd, 2000).

#### ***2.4.5 Changes in the Japanese Wheat Marketing System***

Recent economic constraints and the changing environment of international trade have forced the Japanese government to reconsider its wheat and barley marketing policies. The JFA introduced a reform policy, called "New Wheat and Barley Policies" in 1998 (MAFF, 1998). The stated objective of this policy is to improve the competitiveness of domestic wheat production and to enhance self-sufficiency of food grain in Japan. It is planned to implement this policy during 1999-2004. The new policies include:



“...(1) establishment of a mechanism for private marketing of domestic wheat. The JFA no longer guarantees unlimited purchase of domestic wheat. The policy also includes (2) introduction of new measures for stabilizing management of domestic wheat producer with high productivity-the Wheat and Barley Farming Income Stabilization Fund. This fund will assist improving productivity of domestic wheat production. Level of compensation and payment will determine based on production cost; (3) The “Special Program for Smooth Marketing of Domestic Wheat and Barley” will be re-evaluated and reformed. This is a risk management tool used to manage yield fluctuation. Originally, wheat producers were compensated for decreased yield caused by natural disaster under the Agricultural Insurance System. The new system will compensate not only for decreased yield but also for income losses caused by natural disasters. (4) The resale calculation method will become more transparent, and rationalization of cost sharing among consumers, producers and the JFA will become more appropriate...” (MAFF, 1998 p.3-9).

The JFA continues to import wheat as a state-trader to meet demand that is not filled by domestic wheat supply. However, the JFA is considering introduction of a “Simultaneous Buy and Sell” (SBS) system, which could contribute some flexibility and diversification to wheat imports. The JFA traditionally allocates imported wheat to the millers based on past sales records, which discourages competition among grain traders. The JFA intends to move from allocating sales based on past sales records to allocate the import quota based on the performance of the grain traders (Interview, 1999). This may create new opportunities for some wheat exporting nations to increase their share of the Japanese wheat market.

## **2.5 MILLING INDUSTRY IN JAPAN AND SOUTH KOREA**

### ***2.5.1 Market Structure of the Milling Industry in South Korea***

In the 1970s there were 19 flour-milling companies in South Korea. Extensive consolidation occurred in the 1980s and the 1990s and the number of the milling companies had fallen to eight by 1999 (Table 2.11). The largest four millers controlled 55 percent, 69 percent and 73 percent of the market in 1975, 1985 and 1995, respectively (KOFMIA, 1996). The four major Korean milling companies, holding an aggregate 73 percent of market share in 1999 are Cheil (23%), Daehan (23%), Dongah (15%) and Shin Han (11%) (MAF, 1997). Thus, the milling sector in South Korea can be characterized as having a high degree of market concentration. In March 2000, Dongah and Korea FlourMill (KFM) agreed to merge their operations. The newly merged milling company is expected to have the largest market share. By the end of the year 2000, there are expected to be seven companies in the Korean milling sector (Interview, 2000).

### ***2.5.2 Market Structure of the Milling Sector in Japan***

The four largest flour milling companies: Nisshin, Nippon, Showa and Nitto are called the "Big Four" (Sosland, 1998). They dominate the industry, having 67.9 percent market share in total (Nitto, 2000). Nisshin accounts for 33 percent of the flour market sales while Nippon, Showa and Nitto hold 20, 8 and 6 percent market shares, respectively. The “Big Four” tend to operate at full capacity, involving 24 hours of



operation for 300 days each year. The market share of the Big Four increased from 64.1 percent in 1988 to 67.9 percent in 1997, and the market share of the largest sixteen millers increased from 82.7 percent in 1988 to 85.5 percent in 1997 (JFA, 1997). As the industry consolidated, the number of the milling companies decreased, from 434 in 1965 to 134 in 1999 (Sosland, 1998).

## **2.6 IMPORTANCE OF THE NOODLE MARKET IN JAPAN AND SOUTH KOREA**

A major objective of this study is to evaluate quality preferences of the Japanese and Korean millers for the wheat classes that are utilized in noodle processing. Over the past decade, Canada increased its interest in shifting its export orientation to include high yielding “3-M” (white wheat with medium protein, hardness and gluten strength) varieties as a marketing alternative to the traditional hard red spring wheat varieties. Canadian 3-M (medium protein-level, gluten-strength and hardness) is directed to the oriental noodle market (Martin and Henning, 1989). To this point Canada has been more successful in developing red medium quality wheats than the white medium wheats. The first 3-M variety tailored for Asian noodle market was registered in the Canadian licensing system in 1985 and some six to seven new 3-M varieties have been registered since 1985 (Interview, 2000). Canadian plant breeders introduced new varieties of white hard wheat in 2000, BW263 and BW264, which retain milling quality characteristics of CWRS and have a white seed coat. Hard white wheat has lower level of the polyphenol oxidase enzyme, which causes discoloration in raw noodles, than hard red wheat (Boland et al. 2000). Consequently, hard white varieties are targeted at Asian noodle markets since the white seed coat of these varieties give the desirable dough color for noodle products. Noodles processed in South Korea use flour of semi-hard, medium and soft protein content derived from semi-hard, medium and soft wheat. In Japan, millers use flour of hard, semi-hard and medium protein content, derived from hard, semi-hard and medium wheat.

Australia made major inroads into the noodle market segment in Japan and South Korea in the 1980s. Its market share has grown from six percent to 45.4 percent from 1988 to 1999 in South Korea (KOFMIA, 1999). Australian “customized production contracts” have been considered the key factor in its successful market penetration (Choi and Henney, 1998). The wheat specifications for ASW for Japan and Korea have provided specific blends of different wheat classes to cater to the production of ‘Japanese style’ and ‘Korean style’ noodle processing flour (Interview with Shinhan, 1999). The Australian Wheat Board (AWB) currently exports “100% Australian Noodle wheat” to South Korea (Table 2.3). Australia has done extensive research regarding Korean style wheat-based foods such as noodles, baked products and confectionery products to develop ‘optimum’ wheat varieties acceptable to Korean tastes (Choi and Henney, 1998).

Australia dominates the noodle wheat market in Japan and South Korea, while the Canadian “3-M” has a minor presence and receives little recognition in Korea and Japan. Canada is at an early stage of product development for the Asian noodle markets. The U.S. market presence in the Korean noodle market is being gradually eroded by Australia. The U.S. has a relatively small market presence in the Japanese noodle market (Interview, 1999). Korean and Japanese noodle markets are targeted by three major wheat



exporters--the U.S., Australia and Canada, but each player appears to be at a different stage of wheat market development for the noodle market.

## **2.7 SUMMARY**

The objective of this chapter was to review background features of the Japanese and South Korean milling sectors. This chapter examined features of the wheat and wheat flour markets in Japan and South Korea and the noodle market in both countries. The chapter also overviewed the wheat marketing system in both countries and the marketing activities performed by major exporters.

The assessment concludes that the noodle market segment is increasingly important in both Japan and South Korea. The privatization of the Korean wheat marketing system and recent changes in the Japanese marketing system contribute to competition in the milling sector. Consequently, millers in both countries appear to be increasingly more concerned with the quality of the wheat that they purchase from the international market. An assessment of millers' preference for wheat and flour quality for the noodle market will generate information that can facilitate marketing of noodle making wheat by exporters to meet the needs of flour millers.



**Table 2.1 Imports of Food and Durum Wheat by Major Asian Importing Nations**

| Country <sup>/a</sup><br>(UNIT: 1000MT) | Average<br>(1996-98) | 1998  | 2008<br>(Forecast) | % Change<br>(1998-2008) |
|---|----------------------|-------|--------------------|-------------------------|
| China                                   | 1,601                | 2,000 | 3,294              | 64.7                    |
| South Korea                             | 3,462                | 3,004 | 3,783              | 25.9                    |
| Japan                                   | 6,155                | 6,000 | 6,479              | 8.0                     |
| Taiwan                                  | 1,028                | 1,000 | 1,186              | 18.6                    |

<sup>/a</sup> Source: Koo and Taylor, Agricultural Economics Report No. 423, North Dakota State University, 1999.

**Table 2.2 Economic Indicators for the Korean Wheat Market, 1980-1999**

|      | Per capita<br>Flour<br>Consumption<br><sup>/a</sup><br>(kg) | Per capita<br>GDP <sup>/b</sup><br>(real US\$) | Proportion<br>of Females<br>in Work<br>Force <sup>/b</sup><br>(%) | Growth Rate<br>of GDP <sup>/c</sup><br>(%) | Total<br>Population<br><sup>/b</sup><br>(millions) |
|------|---|--|---|--|--|
| 1980 | 38.4  | 1,597  | 42.8  | -2.1                                       | 38.12  |
| 1981 | 37.0  | N/A  | N/A   | N/A  | N/A  |
| 1982 | 36.2  | 1,834  | N/A   | N/A  | N/A  |
| 1983 | 37.1  | 2,014  | N/A   | N/A  | N/A  |
| 1984 | 37.8  | 2,187  | N/A   | N/A  | N/A  |
| 1985 | 39.5  | 2,242  | 41.9  | 6.5  | 40.81  |
| 1986 | 37.8  | 2,568  | N/A   | N/A  | N/A  |
| 1987 | 38.8  | 3,218  | N/A   | N/A  | N/A  |
| 1988 | 40.0  | 4,295  | N/A   | N/A  | N/A  |
| 1989 | 36.0  | 5,210  | N/A   | N/A  | N/A  |
| 1990 | 34.2  | 5,883  | 47.0  | 9.0  | 42.87  |
| 1991 | 32.1  | 6,757  | N/A   | N/A  | N/A  |
| 1992 | 32.2  | 7,007  | N/A   | N/A  | N/A  |
| 1993 | 33.4  | 7,513  | N/A   | N/A  | N/A  |
| 1994 | 33.6  | 8,483  | N/A   | N/A  | N/A  |
| 1995 | 34.5  | N/A  | 48.3  | 8.9  | 45.09  |
| 1999 | N/A   | N/A  | N/A   | 10.7                                       | N/A  |

<sup>/a</sup> Source: Korea Flour Mills Association (KOFMIA), 1996.

<sup>/b</sup> Source: Statistics Division, United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), 2000; % indicates proportion of female participating in work force of total female population.

<sup>/c</sup> Source: National Statistics Office, South Korea, 2000.



**Table 2.3 Noodle Production in Japan**

|      | <u>Fresh<br/>Chinese<br/>Noodle</u> /a |                           | <u>Dried Noodle</u>      |                       | <u>Instant<br/>Noodle</u> |                       | <u>Pastas</u>            |                       | <u>Total</u>             |                       |
|------|--|---------------------------|--------------------------|-----------------------|---------------------------|-----------------------|--------------------------|-----------------------|--------------------------|-----------------------|
| Year | Prod'n<br>(1,000<br>ton)               | Growth<br>rate<br>(%) / b | Prod'n<br>(1,000<br>ton) | Growth<br>rate<br>(%) | Prod'n<br>(1,000<br>ton)  | Growth<br>rate<br>(%) | Prod'n<br>(1,000<br>ton) | Growth<br>rate<br>(%) | Prod'n<br>(1,000<br>ton) | Growth<br>rate<br>(%) |
| 1989 | 676.3                                  | -0.3                      | 267.3                    | -1.5                  | 313.4                     | 2.3                   | 127.8                    | 0.4                   | 1,384                    | 0.3                   |
| 1990 | 687.9                                  | 1.7                       | 276.0                    | 3.2                   | 317.9                     | 1.4                   | 131.2                    | 2.7                   | 1,413                    | 2.1                   |
| 1991 | 710.4                                  | 3.3                       | 279.3                    | 1.2                   | 320.5                     | 0.8                   | 137.6                    | 4.9                   | 1,448                    | 2.5                   |
| 1992 | 718.3                                  | 1.1                       | 271.9                    | -2.6                  | 322.6                     | 0.7                   | 139.3                    | 1.6                   | 1,453                    | 0.3                   |
| 1993 | 725.2                                  | 1.0                       | 266.6                    | -1.9                  | 321.7                     | -0.3                  | 142.8                    | 2.1                   | 1,456                    | 0.2                   |
| 1994 | 714.4                                  | -1.5                      | 282.6                    | 6.0                   | 305.7                     | -5.1                  | 143.8                    | 0.0                   | 1,446                    | -0.5                  |
| 1995 | 732.2                                  | 2.5                       | 265.8                    | -6.0                  | 313.1                     | 2.6                   | 145.5                    | 1.1                   | 1,457                    | 0.7                   |
| 1996 | 724.8                                  | -0.6                      | 259.3                    | -3.2                  | 324.3                     | 3.3                   | 156.0                    | 7.7                   | 1,464                    | 0.6                   |

/a Source: "Quarterly Publication of Food Industry", Japan Food Agency (JFA), 1997.

/b Note that the reported growth rate is an annual average.



**Table 2.4 Bread Production in Japan**

|      | <u>Pan Bread</u> /a      |                         | <u>Higher</u><br><u>Quality Pan</u><br><u>Bread</u> |                       | <u>Others</u>            |                       | <u>School Lunch</u><br><u>Bread</u> |                       | <u>Total</u>             |                       |
|------|--------------------------|-------------------------|---|-----------------------|--------------------------|-----------------------|-------------------------------------|-----------------------|--------------------------|-----------------------|
| Year | Prod'n<br>(1,000<br>ton) | Growth<br>rate<br>(%)/b | Prod'n<br>(1,000<br>ton)                            | Growth<br>rate<br>(%) | Prod'n<br>(1,000<br>ton) | Growth<br>rate<br>(%) | Prod'n<br>(1,000<br>ton)            | Growth<br>rate<br>(%) | Prod'n<br>(1,000<br>ton) | Growth<br>rate<br>(%) |
| 1993 | 629.4                    | -1.1                    | 342.0   | 2.4                   | 155.8                    | 3.2                   | 54.2                                | -7.4                  | 1,182                    | 0.1                   |
| 1994 | 643.6                    | 2.2                     | 355.4   | 3.9                   | 169.1                    | 8.5                   | 52.8                                | -2.6                  | 1,221                    | 3.3                   |
| 1995 | 622.7                    | -1.2                    | 367.8   | 3.5                   | 177.6                    | 5.0                   | 52.2                                | -1.2                  | 1,220                    | 0.0                   |
| 1996 | 614.5                    | -1.3                    | 376.0   | 2.2                   | 189.5                    | 6.7                   | 49.0                                | -6.2                  | 1,229                    | 0.7                   |

/a Source: "Quarterly Publication of Food Industry", Japan Food Agency (JFA), 1997.

/b Note that the reported growth rate is an annual average.



**Table 2.5 Composition of Population in Japan 1980-1997**

| Year /a | Total<br>Population<br>(millions) | Females in<br>Labor Force<br>(%) /b | Population<br>Aged 0-14<br>(%) | Population<br>Aged 15-64<br>(%) | Population<br>Aged 65 and<br>over (%) |
|---------|-----------------------------------|-------------------------------------|--------------------------------|---------------------------------|---------------------------------------|
| 1980    | 117.06                            | 38.7                                | 23.5                           | 67.3                            | 9.1                                   |
| 1985    | 121.05                            | 39.7                                | 21.5                           | 68.2                            | 10.3                                  |
| 1990    | 123.61                            | 40.6                                | 18.2                           | 69.5                            | 12.0                                  |
| 1995    | 125.57                            | 40.5                                | 15.9                           | 69.4                            | 14.5                                  |
| 1996    | 125.86                            | 40.5                                | 15.6                           | 69.3                            | 15.1                                  |
| 1997    | 126.17                            | 40.7                                | 15.3                           | 69.0                            | 15.7                                  |

/a Source: Statistics Division, United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), 2000.

/b % indicates proportion of the total female population participating in the work force.



**Table 2.6 Production of Instant Noodles in Japan**

| Year<br>/a | <u>Bag Noodles</u><br>(Unit: million bags) |                       | <u>Cup Noodles</u><br>(Unit: million bags) |                       | <u>Total</u><br>(Unit: million bags) |                       | <u>Growth Rate</u><br>(%) /b |                      |
|------------|--|-----------------------|--|-----------------------|--------------------------------------|-----------------------|------------------------------|----------------------|
|            | Prod. Vol.<br>(# of bags)                  | Sales Vol.<br>(1,000) | Prod. Vol.<br>(# of bags)                  | Sales Vol.<br>(1,000) | Prod. Vol.<br>(# of bags)            | Sales Vol.<br>(1,000) | # of<br>unit                 | Sale Vol.<br>(1,000) |
| 1989       | 2,250                                      | 135.9                 | 2,310                                      | 230.3                 | 4,560                                | 368.1                 | 2.2                          | 6.5                  |
| 1990       | 2,180                                      | 140.0                 | 2,375                                      | 244.2                 | 4,555                                | 384.2                 | -0.1                         | 4.4                  |
| 1991       | 2,210                                      | 147.5                 | 2,395                                      | 255.1                 | 4,605                                | 402.6                 | 1.1                          | 4.8                  |
| 1992       | 2,200                                      | 146.9                 | 2,480                                      | 263.5                 | 4,680                                | 410.4                 | 1.6                          | 1.9                  |
| 1993       | 2,210                                      | 147.5                 | 2,500                                      | 265.5                 | 4,710                                | 413.0                 | -2.5                         | 0.6                  |
| 1994       | 2,080                                      | 132.0                 | 2,510                                      | 261.0                 | 4,590                                | 393.0                 | -2.5                         | -4.8                 |
| 1995       | 2,060                                      | 127.0                 | 2,700                                      | 273.0                 | 4,760                                | 400.0                 | 3.7                          | 1.8                  |
| 1996       | 2,040                                      | 125.0                 | 2,850                                      | 288.0                 | 4,890                                | 413.0                 | 2.7                          | 3.3                  |

/a Source: "Quarterly Publication of Food Industry", Japan Food Agency (JFA), 1997.

/b Note that the reported growth rate is an annual average.



**Table 2.7 Schedule of Import Tariffs on Wheat and Wheat flour in South Korea, 1980-2004**

| Year /a | Wheat (%) /b | Wheat Flour (%) /b |
|---------|--------------|--------------------|
| 1980    | 5            | N/A                |
| 1981    | 5            | N/A                |
| 1982    | 5            | N/A                |
| 1983    | 5            | N/A                |
| 1984    | 5            | N/A                |
| 1985    | 5            | N/A                |
| 1986    | 5            | N/A                |
| 1987    | 5            | N/A                |
| 1988    | 5            | N/A                |
| 1989    | 5            | 10                 |
| 1990    | 5            | 10                 |
| 1991    | 5            | 9                  |
| 1992    | 5            | 7                  |
| 1993    | 5            | 5                  |
| 1994    | 5            | 5                  |
| 1995    | 2.88         | 5                  |
| 1996    | 2.76         | 5                  |
| 1997    | 2.64         | 5                  |
| 1998    | 2.52         | 5                  |
| 1999    | 2.4          | 5                  |
| 2000    | 2.28         | 5                  |
| 2001    | 2.16         | 5                  |
| 2002    | 2.04         | 4.76               |
| 2003    | 1.92         | 4.48               |
| 2004    | 1.8          | 4.2                |

/a Source: Korea Flour Mills Association (KOFMIA), 1996.

/b Note that tariff rates are ad valorem rates.



**Table 2.8 South Korean Wheat Imports by Country of Origin, 1970-1996**

| Year /a | The U.S.         |                     | Australia        |                     | Canada           |                     |
|---------|------------------|---------------------|------------------|---------------------|------------------|---------------------|
|         | Quantity<br>(MT) | Market<br>share (%) | Quantity<br>(MT) | Market<br>share (%) | Quantity<br>(MT) | Market<br>share (%) |
| 1970    | 1045             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1971    | 1414             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1972    | 1748             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1973    | 1829             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1974    | 1650             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1975    | 1339             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1976    | 1864             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1977    | 1691             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1978    | 1510             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1979    | 1621             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1980    | 1876             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1981    | 1868             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1982    | 1924             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1983    | 1904             | 100                 | N/A              | N/A                 | N/A              | N/A                 |
| 1984    | 1828             | 100                 | N/A              | N/A                 | 6                | 0                   |
| 1985    | 1918             | 98                  | 30               | 2                   | N/A              | N/A                 |
| 1986    | 1953             | 91                  | 127              | 6                   | N/A              | N/A                 |
| 1987    | 1832             | 88                  | 167              | 8                   | 15               | 1                   |
| 1988    | 1991             | 89                  | 125              | 5                   | 21               | 1                   |
| 1989    | 1798             | 86                  | 218              | 10                  | 45               | 2                   |
| 1990    | 1770             | 84                  | 314              | 15                  | 9                | 1                   |
| 1991    | 1662             | 79                  | 377              | 18                  | 53               | 3                   |
| 1992    | 1517             | 73                  | 508              | 24                  | 56               | 3                   |
| 1993    | 1452             | 71                  | 530              | 26                  | 67               | 3                   |
| 1994    | 1516             | 72                  | 561              | 26                  | 51               | 2                   |
| 1995    | 1451             | 68                  | 613              | 29                  | 57               | 3                   |
| 1996    | 1553             | 68                  | 651              | 29                  | 73               | 3                   |

/a Source: Park J.N., Lee Y.S. and Ghi J.Y. (1997), Chapter 5, p341, "Wheat and Wheat Flour".



**Table 2.9 Definitions of Wheat Class by Origin, by Category and by End-use**

|                                      | Wheat Class        | Description                  | Wheat Category                   | End-use       |
|--------------------------------------|--------------------|------------------------------|----------------------------------|---------------|
| The United States (U.S.)<br>/a, b, c | WW/SW              | Western White/Soft White     | Soft wheat                       | Confectionery |
|                                      | HRW<br>(13.0%)     | Hard Red Winter              | Semi-hard wheat                  | Noodles/Bread |
|                                      | HRW<br>(11.5%)     | Hard Red Winter              | Medium wheat                     | Noodles       |
|                                      | DNS<br>(14.0%)     | Dark Northern Spring         | Hard wheat                       | Bread         |
| Australia                            | ASW                | Australian Standard White    | Medium wheat                     | Noodles       |
|                                      | AS                 | Australian Soft              | Soft wheat                       | Confectionery |
|                                      | APH                | Australian Prime Hard        | Hard wheat                       | Bread         |
|                                      | AH                 | Australian Hard              | Hard wheat or Semi-hard wheat /d | Noodles/Bread |
|                                      | Noodle Wheat       | 100% Australian Noodle Wheat | Medium wheat                     | Noodles       |
| Canada                               | CWRS /c<br>(11.5%) | Canada Western Red Spring    | Medium wheat                     | Noodles       |
|                                      | CWRS /c<br>(12.5%) | Canada Western Red Spring    | Medium wheat                     | Noodles       |
|                                      | CWRS<br>(13.5%)    | Canada Western Red Spring    | Hard wheat or Semi-hard wheat /d | Bread         |

/a Source: Korea Flour Mills Association (KOFMIA), 1996.

/b Note that millers in South Korea divide imported wheat into three categories: hard wheat, medium wheat and soft wheat, while millers in Japan divide imported wheat into four categories: hard wheat, semi-hard wheat, medium wheat and soft wheat. The hard wheat category from South Korea has similar quality specifications to semi hard wheat category in Japan. Since this study includes comparison of these two markets, the hard wheat category of South Korean market is described as “semi-hard” wheat to avoid confusion. The rest of this thesis uses the term, semi-hard wheat to refer hard wheat category in South Korea.

/c Canadian 3-M (medium protein-level, gluten-strength and hardness) is oriented to the oriental noodle market segment (Martin and Henning, 1989).

/d AH and CWRS (13.5%) are classified as Hard wheat category in South Korea. These wheat classes are classified either as hard wheat or semi-hard wheat category in Japan depending on quality conditions of wheat that are imported in a particular year.



**Table 2.10 Japan, Wheat Imports by Country of Origin, 1972/73 to 1996/97**

| Year /a | Australia        |                     | The U.S.         |                     | Canada           |                     |
|---------|------------------|---------------------|------------------|---------------------|------------------|---------------------|
|         | Quantity<br>(MT) | Market<br>Share (%) | Quantity<br>(MT) | Market<br>Share (%) | Quantity<br>(MT) | Market<br>Share (%) |
| 1976/77 | 1,076            | 19                  | 3,280            | 58                  | 1,321            | 23                  |
| 1977/78 | 1,158            | 20                  | 3,180            | 56                  | 1,352            | 24                  |
| 1978/79 | 1,161            | 21                  | 3,187            | 57                  | 1,236            | 22                  |
| 1979/80 | 1,068            | 19                  | 3,204            | 58                  | 1,300            | 23                  |
| 1980/81 | 914              | 15                  | 3,525            | 59                  | 1,463            | 25                  |
| 1981/82 | 943              | 17                  | 3,358            | 60                  | 1,335            | 24                  |
| 1982/83 | 934              | 17                  | 3,294            | 59                  | 1,357            | 24                  |
| 1983/84 | 1,043            | 18                  | 3,441            | 58                  | 1,416            | 24                  |
| 1984/85 | 1,039            | 18                  | 3,324            | 58                  | 1,385            | 24                  |
| 1985/86 | 1,020            | 18                  | 3,282            | 59                  | 1,277            | 23                  |
| 1986/87 | 964              | 17                  | 3,261            | 58                  | 1,351            | 24                  |
| 1987/88 | 993              | 18                  | 3,219            | 57                  | 1,455            | 26                  |
| 1988/89 | 1,007            | 19                  | 2,948            | 55                  | 1,416            | 26                  |
| 1989/90 | 1,097            | 21                  | 2,807            | 53                  | 1,440            | 27                  |
| 1990/91 | 1,055            | 19                  | 3,110            | 57                  | 1,311            | 24                  |
| 1991/92 | 1,053            | 18                  | 3,219            | 55                  | 1,556            | 27                  |
| 1992/93 | 1,041            | 18                  | 3,378            | 57                  | 1,493            | 25                  |
| 1993/94 | 1,126            | 19                  | 3,450            | 58                  | 1,403            | 23                  |
| 1994/95 | 1,252            | 22                  | 3,068            | 54                  | 1,410            | 25                  |
| 1995/96 | 1,146            | 19                  | 3,416            | 57                  | 1,455            | 24                  |
| 1996/97 | 1,500            | 21                  | 3,250            | 54                  | 1,500            | 25                  |

/a Source: International Wheat Council (IWC), 1997.



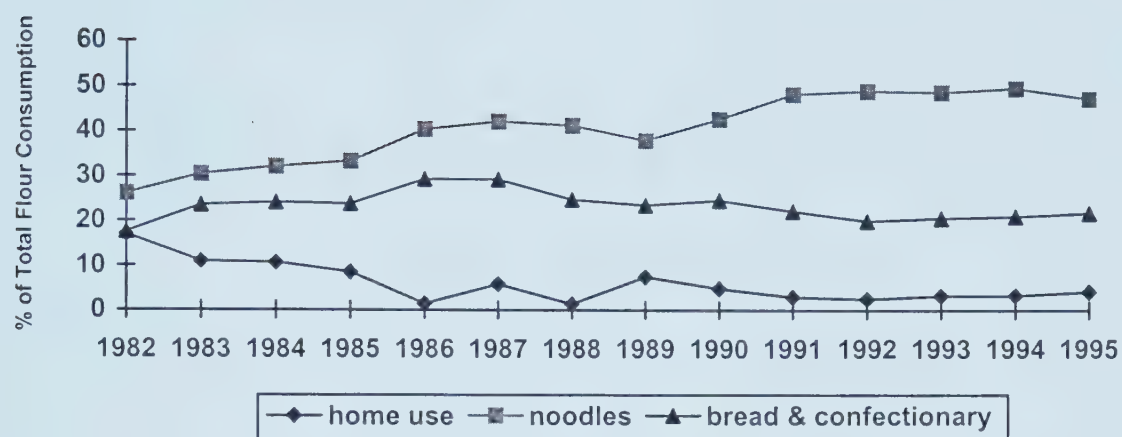
**Table 2.11 Changes in Number of Flour Mills and Annual Milling Capacity in South Korea, 1959 to 1994**

|   | Year /a      | No. of Flour Mills | Milling Capacity<br>per year<br>(1,000 tones) |
|---|--------------|--------------------|---|
| Recovery from the Korean War, and Expansion                                   | 1959         | 22                 | 1,386   |
| Recession in the Korean milling industry                                      | 1960-1966    | 22-23              | 1,318-1,420                                   |
| High Growth Period  | 1967-1970    | 22-23              | 1,640-1,950                                   |
|   | 1971-1972    | 24                 | 2,080   |
| Depression in the Korean milling industry                                     | 1973-1974    | 24                 | 2,680   |
|   | 1975         | 18                 | 2,680   |
| Stabilization Policy by the Korean government                                 | 1976-1977    | 18                 | 2,680   |
|   | 1978-1982    | 14-16              | 2,680-2,842                                   |
|   | 1983         | 13                 | 2,829   |
| Liberalized Wheat Trade, and free competition in the Korean milling industry. | 1984-present | 8                  | 2,829-3,141                                   |

/a Source: Kim, S.K. 1994



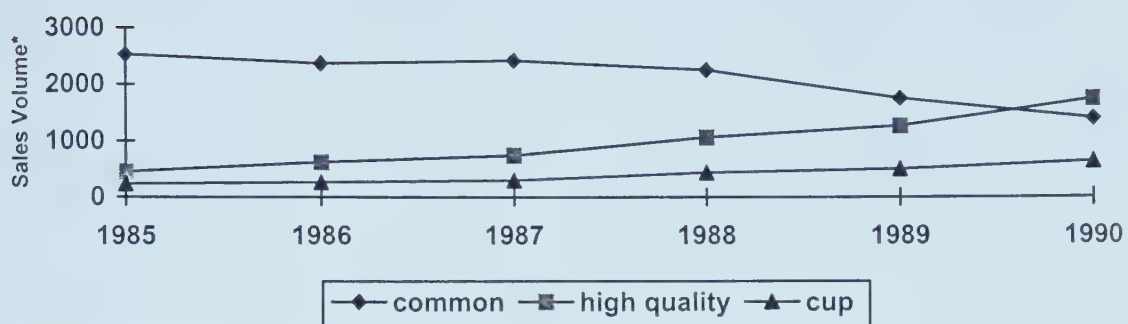
Figure 2.1 South Korean Wheat Flour Consumption by End-use  
(% of Total Flour Consumption) /a



/a Source: Korea Flour Mill Association (KOFMIA), 1996.



**Figure 2.2 Sales Volumes of Instant Noodles by Types in South Korea**  
Sales Volume (million in pieces) /a



/a Source: Korea Flour Mill Association (KOFMIA), 1996.



### 3. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

#### 3.1 INTRODUCTION

As noted in Chapter 2, noodles are major products of wheat flour in both Japan and South Korea. Wheat usage in noodle processing has been reported to be 27 percent and 50 percent of total wheat usage, in Japan and South Korea, respectively (KOFMIA, 1999). The evaluation of quality characteristics of noodle processing wheat and wheat flour that is preferred by both Japanese and Korean millers is necessary for the successful development of product and marketing strategies by wheat exporters. However, to this point, there has been little study to identify preferences for wheat and wheat flour quality by millers for noodle uses. The scope of this study is limited to noodle wheat market as defined in Chapters 1 and 2. The objective of this chapter is to review literature and to develop a model capable of evaluating the important quality characteristics of wheat and wheat flour that is used in processing noodle flour.

The chapter is organized as follows. The second section discusses some of the important issues involved in analyzing demand for the noodle wheat market. Previous demand studies of wheat market are examined. The third section presents the theory of discrete choice models, followed by introduction of the theoretical framework that is applied in this study. In the fifth and sixth sections, two methodologies are presented that are the focus of data collection in this study. These are the stated preference method (SPM) and the semantic differential scale (SDS) method. The chapter ends with a summary and the conclusions to this point.

#### 3.2 LITERATURE REVIEW

Previous studies have examined features of the international wheat market and the characteristics of major wheat importers and exporters. Some of these studies have focused on Asian wheat import markets. The quality characteristics of wheat and flour in the Asian markets are specifically assessed in some of the studies (Esfahani and Stanmore 1994a, Esfahani and Stanmore 1994b, Larue 1991, Goodwin and Espinosa 1991, Wilson 1989 and Veeman 1987). Approaches that have been utilized in previous studies to evaluate wheat demand in Asian markets are discussed next.

##### 3.2.1 *Demand Analysis of Asian Wheat Markets*

Many of the early studies on Asian wheat demand used traditional methods of demand analysis. These have involved estimating models of direct demand, substitution, market share models, complete demand systems such as almost ideal demand system (AIDS), Armington model, or the translog expenditure function. These approaches mostly evaluate import demand under the assumption that wheat is a homogenous commodity.

Honma and Heady (1984) used the Armington model to analyze Japanese wheat import demand by class and country of origin. Others have used a complete demand system such as the AIDS model, the Rotterdam model, and Barten's system-wide approach to analyze the Japanese import demand for wheat classes (Henning 1986, Agriculture Canada 1987, Lee, Koo, and Krause 1994, Schmizt and Wahl 1998, Kim and Chen 1997, Chen and



Kim 1998). Wilson and Gallagher (1990) used a nonlinear market share function to examine the behavior of wheat class market shares in four different regions in the world. Wilson (1994) applied a translog expenditure model to derive the demand function for wheat by class and country of origin for Pacific Rim countries that include Japan and South Korea. Mao *et al.* (1997) applied a multiple output-multiple input translog cost function for the Japanese flour industry to analyze Japanese import demand for wheat.

Many of these studies reach significantly different conclusions on the demand for wheat in Japan or in Asia. The traditional approaches to the evaluation of wheat demand apply conventional consumer theory to derive demand functions, and these demand functions differ in terms of the functional forms and other features of model specification. Different model specifications and functional forms lead to different outcomes from the estimation. Some models have restrictive assumptions that may lead to estimation bias. For instance, the Armington model has been used to estimate import demand for product differentiated by country of origin. This model, however, suffers from two restrictive assumptions. Firstly, the Armington model imposes homotheticity, which implies that the relative distribution of import shares does not respond to changes in expenditures. This feature also imposes constant elasticity of substitution across pairs of commodities. In other words, the extent of substitution between two different classes of wheat is constant regardless of changes in their prices. Consequently, the restrictive assumptions of this model are likely to result in estimation bias (Wilson, 1994).

To improve this problem of the Armington model, more flexible functional forms have also been applied in the estimation of wheat demand systems. These include the almost ideal demand systems (AIDS), translog cost function (dual) and normalized quadratic profit function (dual). The AIDS model relaxes the homotheticity assumption. Other dual based functional forms such as the translog and normalized quadratic cost functions can also retrieve information on demand parameters from estimated dual functions without directly estimating the underlying utility function. Although these models are improvements relative to the Armington model, they also have weaknesses, such as the assumption of separability as a maintained hypothesis, which may also be a source of estimation bias. Similarly, the AIDS and the other flexible functional forms (FFF) such as the translog and normalized quadratic cost functions apply the assumption of product aggregation in demand estimation. Since wheat is differentiated into different classes based on quality characteristics, estimating wheat demands assuming that wheat is a homogenous commodity may not be appropriate.

A further issue is that most previous studies on wheat demand have been conducted applying secondary data. A problem with sourcing secondary data is that wheat price data are often hard to obtain, particularly for wheat of Canadian and Australian origin. Wheat exports from these two countries occur through a single exporter, the Canadian Wheat Board (CWB) and the Australian Wheat Board (AWB). There is a lack of transparency in the price information released. For instance, available export price data on sales to individual importers of Canadian wheat is based on official in-store price quotations. Actual transaction price information is hard to obtain for Canadian wheat. Reliance on asking prices rather than on actual transaction prices might provide elasticity estimates



from demand estimation that are unreliable for policy purposes. Application of different data sources and time periods may also result in significant differences in the conclusions of different wheat demand analyses.

Numbers of empirical studies investigating the nature of Asian wheat demand have used wheat trade data that is differentiated by wheat class and by sources. None of these studies have explicitly focused on evaluation of the preferences of Asian wheat importers for wheat for the noodle market. Millers in importing countries tend to use different wheat classes, depending on consumers' preferences for different end products (Lee *et al*, 1994). It is important to evaluate wheat demand by end-use since importing countries use different classes of wheat depending on their preferences for different end products (Mao *et al*, 1997). As emphasis on market competition increases, millers in Japan and South Korea are putting increased emphasis on flour specifications based on end products (Interview, 1999).

### ***3.2.2 Effect of the Organization of the Marketing System on Wheat Demand***

Some of the previous analyses of competition in the world wheat market have focused on the effects of the organization of the marketing system on competition. Abbott and Young (1999) demonstrated that the operation of Japan Food Agency (JFA), a state trading enterprise (STE), tends to isolate Japanese domestic markets from world wheat market conditions. They hypothesized that countries in which STE handle trade may be less responsive to price differences between exporters and are more likely to rigidly depend on historical shares of import sources than countries in which private firms seek the most economic source of supply. Wilson and Gallagher (1990) found that Japanese millers are less price responsive and have more rigid preferences for imported wheat relative to millers in other markets such as Asia, Latin America and the U.S. They conclude that this is due to the JFA's wheat importation operations. They suggested that the difference that they observed in the price responsiveness (or elasticities of substitution) and the preference for wheat classes between developing regions of Asia versus Japan may be attributed to the uniqueness of the wheat importation system in Japan. Millers and end users in Japan are insulated from international prices, but can request quality specifications from the JFA. Dahl and Wilson (2000) hypothesize that private wheat buyers would have a greater incentive to focus on higher quality and be more willing to pay premiums if greater quality enhances their profits. Most of these studies indicate that the organization of particular wheat marketing systems may result in differences in millers' behavior and choices of imported wheat. Japan has a single buyer, while South Korea has private wheat buyers. The conclusions outlined above suggest that demand of private wheat buyers in South Korea may be more price responsive than is the case for wheat buyers in Japan, due to an open market system in South Korea. This study will compare the two different marketing systems as a means of an assessment of the organizational impact of the wheat marketing system on millers' quality preferences. In this study, the preferences of Japanese and Korean millers for wheat and flour quality characteristics are directly compared based on evaluating survey data on these preferences.



### ***3.2.3 Importance of Wheat Quality Characteristics***

One facet of changes in the competitive environment in international wheat markets has been that differentiation of wheat by quality characteristics has become increasingly important (Wilson, 1989). The degree of product differentiation in wheat marketing and trading has increased significantly in the last two decades and the quality of wheat exported is viewed as a competitive factor in international trade. As the importance of product differentiation on wheat quality has become evident, numbers of studies have focused specifically on valuation of wheat quality characteristics (Esfahani and Stanmore 1994a, Esfahani and Stanmore 1994b, Larue 1991, Wilson 1989 and Veeman 1987).

Two methods for commodity quality evaluation are the hedonic approach and discrete choice analysis. The latter may be applied both to revealed preferences (actual market data) and stated preferences (hypothetical market data). The hedonic price framework and the discrete choice framework using revealed preferences data both use observed market data to determine the quality characteristics of a commodity that may be important to a consumer or buyer. The discrete choice framework based on stated preference data, or experimental choice analysis, uses hypothetical market data generated through a stated preference survey to analyze buyers' contingent behavior.

The hedonic price framework derives estimates of the marginal implicit values of important attributes of a product, given an assumption that firms are perfectly competitive profit maximizers, purchasing heterogeneous inputs. This approach has been applied to wheat in several studies (Stanmore and Esfahani 1994a, Stanmore and Esfahani 1994b, Larue 1991, Wilson 1989 and Veeman 1987).

Veeman (1987), Wilson (1989) and Larue (1991) tested for premium/discounts of major characteristics of wheat and country of origin for Canadian, Australian and U.S. wheat using the hedonic approach. Veeman (1987) concluded that wheat from the U.S. was discounted in favor of Australian wheats. Wilson (1989) found that Canadian-origin wheat received a substantial premium relative to U.S. wheat in the Rotterdam market. This conclusion held relative to Australian-origin wheats in the Japanese market. Larue (1991) found that Canadian wheat commanded a premium over Australian and U.S. wheats. These studies differ in model specification and data and apply to different time periods.

In terms of wheat quality characteristics, Veeman's model specified protein content, color, country of origin as explanatory variables and covered the time period from 1976 to 1984. Wilson specified color of wheat, country of origin, hardness of wheat, protein level and International Wheat Price Index (IWC) in the empirical model and applied a data set from 1972 to 1987. The data in Larue's model covered the period starting in 1980-1981 and ending in 1988-89. The wheat characteristics used in his model were protein content, test weight, falling number, 1000 kernels weight, dockage, foreign material content, ash, and moisture.



Veeman used data on nine different wheats for their prices and quality characteristics, and pooled time series and cross-sectional data on wheat prices. Wilson pooled the wheat price based on specific locations. He estimated four separate models: two freight on board (FOB) export locations in the U.S., FOB Gulf and FOB Pacific, and two international destinations, cost, insurance and freight charge (CIF) Rotterdam and CIF Japan. If these markets have one predominant end use, this data pooling would have been appropriate and there would be no need to differentiate by end use. However, the Japanese wheat market has multiple wheat end uses, hence Wilson's pooling of wheat is not appropriate.

Larue, in contrast, argued that the wheat price data should be pooled based on end use. He divided the data into four categories based on end use: high-protein wheats, medium-protein wheats, low-protein wheats, and durum wheats. He noted that high protein wheat is mostly used in making of bread flours, and medium protein wheat is used in making European-style loaf bread, Arabic and Indian style flat breads, steamed breads and most types of noodles. Low protein wheat is considered to be used in making flour for biscuits, cakes, pastry and unleavened breads. Although Larue's argument on pooling wheat data based on end use is plausible, the approach to categorize wheat does not provide the finer detail that may be of interest for specific sectors. He groups European style bread and most types of noodles in one category (medium protein). However, characteristics such as color, cleanliness and the level of amylase activity are much more important for noodles than flat bread, whereas the degree of hardness is extremely important for flat bread production (Stanmore and Esfahani, 1994b). Although both noodles and European style bread use medium protein wheat, for more precise product classification by end use, these categories should be clearly separated due to the different emphasis on wheat quality characteristics.

Although the studies noted above emphasize the importance of quality characteristics of wheat, they have conflicting findings on the values of wheat quality characteristics. This may arise from the different data used and the markets analyzed. Few studies have directly focused on the preferences of Japanese and South Korean wheat millers. Discrepancies among the conclusions of several studies on Asian wheat demand may be due to the differences in the way each author framed the hedonic model for wheat quality evaluation.

One weakness of the hedonic model is its assumption that wheat exporters are perfect competitors. In contrast, the international wheat market has been claimed to have some characteristics of an oligopolistic nature (Abbott and Young, 1999). Most international wheat sales are made at negotiated and unannounced prices and it is difficult for competing exporters to observe the same prices. Thus, the international wheat market is far from being perfectly competitive. Wheat price data for sales of Canadian and Australian origin are hard to obtain since the Canadian Wheat Board (CWB) and the Australian Wheat Board (AWB) mostly release official in-store price quotations, rather than actual export transaction prices. At times, these price data may be substantially different from actual transaction prices. Similarly, only average price estimates are reported for US wheat sales. Valuation of wheat quality characteristics based on the price



quotations or average prices instead of the actual export transaction prices may lead to estimation bias and produce inappropriate policy recommendations. Stanmore and Esfahani (1992) claimed that the hedonic framework should not be used to analyze strategic policies such as price discounts or export subsidies since it does not have the capacity to handle such strategic considerations. Such considerations reflect imperfectly competitive features of wheat import markets.

Discrete choice analysis may be more appealing in valuation of product quality characteristics, since many of these situations do involve discrete choices. This is an appropriate framework to achieve the objectives of this study, which is to evaluate millers' preference of wheat and flour quality characteristics. In this study, a discrete choice approach that applies to data elicited by stated preference methods (SPM) is used to analyze millers' preference of wheat and wheat flour quality characteristics. The SPM generates primary market data such as data on millers' hypothetical choices of wheats with different quality characteristics. Since the Japanese wheat trading system started a series of reform policies in 1998, more current data on wheat market is required to evaluate the implication of the policy reforms on the market demand. Thus, implementation of the SPM to generate primary data on millers' preference appears to be timely and appropriate for analyses of Japanese and Korean wheat markets. Prior studies have identified important wheat quality characteristics to consider when designing the SPM survey.

#### **3.2.4 Importance of Country of Origin**

Some recent studies have developed models that differentiate grain by its country of origin, allowing political factors to play a role (Alston *et al.* 1989, Esfahani 1995, O'Rourke 1994, Schmitz and Wahl 1998, Veeman 1991, Mao *et al.* 1997). Esfahani (1995) indicated that there have been some changes in the market composition of Japanese wheat market since 1960. Canada lost its position as the largest exporter of wheat to Japan, while the United States experienced the largest increase in market share in Japan. This author suggested that the change in market composition may have occurred due to political bias and diplomatic relationships among trading nations influencing the decision making on wheat importation to Japan. Alston, Carter and Jarvis (1989) also concluded that the JFA has managed wheat imports with quotas that favor the United States over other exporters due to the political and economical importance of the United States to Japan.

Wilson *et al.* (1987) demonstrated that elasticities of substitution among different wheat classes were relatively low in the higher quality wheat market segment in Japan due to managed trade on wheat importation administered by JFA's. Overall, review of studies on Japan's wheat importation suggests that non-price factors extensively affect demand for imported wheat by millers in Japan. These factors may include the loyalty of importers toward specific suppliers or sources, trade relationships and strategies by exporters. Therefore, country of origin can be considered as one important determinant affecting millers' choice decisions for imported wheat. The country of origin may reflect the cumulative effects of an exporting nation's marketing activities, service strategies by exporting and importing nations, factors such as "origin loyalty" and other features of



trade relationships. In this study, country of origin is postulated as one of the factors that influence millers' wheat purchasing decisions.

### **3.3 OVERVIEW OF DISCRETE CHOICE ANALYSIS**

In a discrete choice framework, a decision-maker is modeled as selecting the discrete alternative with the highest utility among those available at the time the choice is made. In the context of demand analysis, discrete choice analysis is based on Lancaster's (1966) interpretation of consumer theory that consumers derive utility from the attributes of products. The preferences for products are indirect in the sense that they arise because the products are needed to "produce" utility, from household's production and consumer activities. Given this assumption, the attractiveness of an alternative expressed by a vector of attribute values is reducible to a scalar and this index of attractiveness represents a measure of utility, a measure that the decision-maker attempts to maximize through his or her choice. Thus, the attractiveness of an alternative is evaluated in terms of a vector of attribute values and other relevant variables, and the attribute values are measured on a scale of attractiveness that can be ordinal or cardinal in nature.

Discrete choice analysis applies the principle of consumer's utility maximization, but allows for the consumption of discrete quantities of goods and services in a manner that permits the consumption of one or more goods to be zero. Thus, the basic problem confronted by discrete choice analysis is the modeling of choice from a set of mutually exclusive and collectively exhaustive alternatives. An operational model consists of a parameterized utility functions in terms of observable independent variables and unknown parameters and the values of these parameters are estimated from a sample of observed or hypothetical choices made by decision makers when confronted with a choice situation. A utility function can be either ordinal or cardinal. Ordinal utility is a mere mathematical expression of a preference ranking of alternatives, hence it is unique only up to an order-preserving transformation. Conventionally, discrete choice models assume ordinal utility unless otherwise stated. (Ben-Akiva and Lerman, 1985). Discrete choice models have been widely applied in fields such as marketing (Louviere and Woodworth, 1983), transportation planning (Ben-Akiva and Morikawa, 1990), agricultural market studies (Karugia, 1997; Untershultz et al, 1998), and environmental and recreation studies (Louviere, 1992; Adamowicz et al., 1994, 1997).

### **3.4 THE THEORETICAL BASIS AND DERIVATION OF THE MULTINOMIAL LOGIT MODEL**

The purpose of this section is to outline the theoretical foundation for deriving a multinomial logit model, which is used to estimate values of attributes identified to be significant to millers in Japan and Korea. In empirical application of discrete choice analysis, it is necessary to explain experimental observations of inconsistent and nontransitive preferences. Ben-Akiva and Lerman (1985) note that decision makers may not necessarily select an identical alternative in repetitions of the same choice situations, or choice behavior may violate the transitive preference assumption if altered choice sets are provided. Hence, a probabilistic choice mechanism is developed to explain these behavioral inconsistencies of decision-makers. This captures the effects of unobserved variations among decision-makers and unobserved attributes of the alternatives. It can



also take into account pure random behavior and errors due to incorrect perceptions of attributes and choices of suboptimal alternatives (Ben-Akiva and Lerman, 1985). In this context, these authors point out that the discrete choice framework is superior to conventional consumer theory in terms of describing more realistically the behavior of decision-makers. Probabilistic discrete choice models are typically based on concepts of random utility theory. The indirect utility function can be expressed as the sum of a systematic component, which is expressed as a function of the attributes presented, and a random component (Adamowicz et al. 1994). Following Ben-Akiva and Lerman (1985), Bastell and Louviere (1991) and Adamowicz (1992), the model can be expressed as:

$$U_{in} = V(X_{in}) + e(X_{in}) \quad (3.1)$$

where:

$U_{in}$  is person  $n$ 's utility of choosing alternative  $i$ ;

$V$  is the systematic component of utility;

$e$  is a random element;

$X_{in}$  is a vector of attribute values for alternative  $i$  as viewed by respondent  $n$ .

Total utility,  $U_{in}$  is a sum of observable and unobservable components, which can be expressed as  $V$  and  $e$ , respectively. The systematic component is a function of observable attributes of products or brands of a product and individuals, while the random component relates to variations in choice due to within- and between-individual variance, omitted variables, measurement errors and imperfect information (Ben-Akiva and Lerman, 1985; Karugia, 1997). Consequently, this model is referred as a random utility model (RUM). Alternative  $i$  is chosen over alternative  $j$  if  $U_{in} > U_{jn}$ . The probability of individual  $n$  choosing alternative  $i$  is

$$\pi_n(i) = \Pr(V_{in} + e_{in} \geq V_{jn} + e_{jn}; \text{ for all } j \in C_n) \quad (3.2)$$

where  $C_n$  is the choice set for respondent  $n$ . If the choice set,  $C_n$ , consists of more than two alternatives, this leads to a multinomial choice framework. In this instance, it is necessary to characterize the complete joint distribution of all the disturbances (Ben-Akiva and Lerman, 1985).

In this study, the non-nested multinomial logit (MNL) is applied to examine millers' preferences for wheat and flour in Japan and Korea. Assuming that the error terms are independently, identically (IID) and Gumbel distributed with a scale parameter  $\mu > 0$ , the probability of choosing an alternative  $i$  is defined as the MNL model and expressed as:

$$\pi_n(i) = \frac{\exp(\mu V_{in})}{\sum_j \exp(\mu V_{jn})} \quad (3.3)$$

Assuming that  $V_{in}$  is linear in parameters, the functional form can be expressed as:

$$V_{in} = \beta_1 + \beta_2 x_{in2} + \dots + \beta_k x_{ink} \quad (3.4)$$

where:

$V_{in}$  is respondent  $n$ 's conditional indirect utility function;



$x_{ink}$  is kth attribute values for alternative  $i$  as viewed by respondent  $n$ ;

$\beta_1$  to  $\beta_k$  are coefficients to be estimated.

The functional form expressed in equation (3.4) is additive and indicates that the factors are independent in their respective effects on consumer utility. Thus, interaction effects are assumed to be negligible and therefore only main effects are assessed (Unterschultz *et al.*, 1997).

Ben-Akiva and Lerman (1985) note that the assumption of independent and identically distributed (IID) disturbances represents an important restriction. It constrains all the disturbances to have the same scale parameter  $\mu$ . The scale parameter  $\mu$  is present in each of the terms in equation (3.3). Since it is not readily identifiable, it is usually normalized to 1. The scale parameter  $\mu$  has a significant role in the model by reflecting homoscedasticity of disturbance terms. Ben-Akiva and Lerman point out that the scale parameter  $\mu=1$  implies that the variances of the random components of the utilities are equal and the systematic component of the indirect utility explains choice behavior efficiently.

In some cases, this assumption may be difficult to defend. For instance, when differences in demand generate different consistency levels in observed behavior across individuals, this affects the variances of the distribution of the disturbances. In this case, it may be necessary to relax the assumption that disturbance terms are distributed as IID Gumbel distribution. That is to say, if the error terms are independent, but not identically distributed, this allows heteroscedasticity in them to be expressed. Swait and Adamowicz (1996) developed a specific model form that permits testing of the proposition that consumer choice can be affected by context and decision environment complexity. These authors concluded that choice complexity is an important factor in modeling choice behavior. In this study, the target respondents are relatively homogenous and their decision environments are considered to be similar. Hence, the non-nested MNL that assumes homoscedasticity is adopted.

Another important aspect of the MNL is the property of independence from irrelevant alternatives (IIA). According to this assumption, if some alternatives are removed from a choice set, the relative choice probabilities from the reduced choice set are unchanged. In other words, the choice probabilities from a subset of alternative are dependent only on the alternatives included in this subset and these are independent of any other alternatives that may exist (Ben-Akiva and Lerman, 1985). The IIA property of the MNL is a probabilistic version of the concept of transitivity and the validity of the choice axiom depends on the structure of the choice set. If alternatives are perceived to be similar, they will be treated as a single alternative, resulting in violation of the IIA assumption. Thus, the validity of the choice axiom should be restricted to choice sets with distinct alternatives and an assumption of a choice hierarchy should be introduced. A choice hierarchy assumes that the choice axiom applies at each level of the hierarchy but the choice axiom is not valid for the full set of alternatives. This is to say, the choice axiom may be valid for a choice 'within' a subset, and for a choice 'between' subsets, but this does not apply for a choice from the whole set of alternatives. In the context of this



proposition, it is important to understand whether a decision-maker does indeed decompose his/her decision structure into a hierarchical choice process. Thus there is a need to understand the specific structure of the decision process.

Depending on the type of choice hierarchies and structure of decision process, different choice probabilities can be derived. Bastell and Louviere (1991) note that violation of the IIA arises because of heterogeneity in tastes and preferences of decision makers, hence the MNL might be generally more appropriate if specified to account for individual specific differences. With the proper specification of the indirect utility function, as with inclusion of individual difference terms that interact with attribute variables, violation of the IIA can be minimized. The model specified in this study incorporates individual-specific attributes as shown in equation (3.3).

Suppose that a single vector of coefficients  $\beta$  is defined and the scale parameter  $\mu=1$ , equation (3.3) can then be expressed as:

$$\pi_n(i) = \frac{\exp(\beta'X_{in})}{\sum_j \exp(\beta'X_{jn})} \quad (3.5)$$

where :

$\pi_n(i)$  = the respondent n's choice probability of alternative  $i$ ,

$X_{in}$  and  $X_{jn}$  = vectors describing the attributes of alternative  $i$  and  $j$ , and

$\beta$  = vector of coefficients.

To capture differences in respondents' tastes and preferences, the MNL model includes individual-specific attributes in the design of matrix  $X$ . In experimental design, decision attributes  $X_i$ s are termed "factors", and the values that each factor takes on in the experiment are called "levels". The maximum likelihood method is used to estimate the model of equation (3.4). The econometric program, LIMDEP version 7.0, of Greene (1995) is used for this purpose.

In the study of Quagraine *et al.* (1998), a MNL model was tested that was nested. The nesting structure of that model assumes that there are two levels of the decision making-process. In that study, a consumer first decides to purchase or not to purchase. After the decision to purchase has been taken, based on the stated product descriptions, the consumer then chooses from the two available product alternatives (Quagraine *et al.*, 1998). Since the focus of that study is at the retail level and involves assessing the effects of selected demographic features on consumer choices of red meat, the nesting structure is applied in that model to take into account the effect of demographic features. In contrast, in this study, both in Japan and South Korea, the respondents to the survey are quality managers and sales managers of firms in the milling industries, who may be considered to have relatively similar levels of knowledge and experience in the flour milling business. Most of the respondents are senior managers who had at least ten years of experience in milling technology. Therefore, respondent differences are not probed since respondents are considered to be homogenous. The questionnaire contains technical questions on wheat and flour quality characteristics from a milling perspective, which



requires specific knowledge of milling technology. Consequently, individual respondents' tastes and preferences are assumed to have a minor role in affecting their choices. Therefore, this model assumes that there is only one level of decision-making in the wheat purchase decision process of millers. A non-nested multinomial logit model (MNL) such as is outlined above and indicated in equation (3.4) is used in this study to analyze data obtained from the survey questionnaire using stated preference (SPM) methods. The empirical application of this model requires identification of the specific factors and the levels of each factor. In the empirical analysis, hypothetical choices based on different combinations of factor levels are required to estimate the MNL model. Determinations of alternatives, factors and factor levels specific to this study are discussed in the next chapter. Formulation of the survey questionnaire and the survey method are also outlined in the following section. The following section presents an overview of the stated preference method and its applicability in this study.

### **3.5 REVIEW OF STATED PREFERENCE (SPM) METHODOLOGY**

The SPM approach was motivated by developments in choice modeling, discrete multivariate analysis, and conjoint analysis (Bastell and Louviere, 1991). The SPM allows the assessment of potential demand for a new product, buyers' perceptions of a new product or the estimation of the response to a change in an existing product (Kuperis *et al.*, 1997). Louviere (1992) noted that real markets often exhibit limited ranges of variations in important behavioral or managerial variables and new products or services may contain features or enhancements not yet available in real choice data. By using SPM to elicit buyers' contingent behavior on wheat purchases, this study can extend the range of variations in observed behavioral variables. This feature of the SPM is particularly appealing since no observations are available on actual market choices of buyers for some classes of noodle processing wheat class from some wheat exporters, i.e. Canada.

The SPM can be applied to elicit Japanese and South Korean millers' stated quality preferences for wheat characteristics designed for noodle flour. From this information, exporters can determine the relative importance of quality characteristics, as these are perceived by millers in Japan and Korea. This may facilitate the design of wheat breeding programs and market development plans. The SPM can also generate information on the effects of country of origin of wheat on Japanese and Korean millers' choice behavior.

A potential weakness of the SPM is that people may not respond to the questions in the same way that they react to actual market choices. Heaner *at al.* (2000) examined the ability of a stated preference (SP) model in predicting actual choice behaviors. They compared data of stated preference model (SPM) with data of revealed preference (RP) model and examined the predictive power of these models in a holdout sample. Their results illustrate the importance of data quality in accuracy of behavioral prediction. The study suggests that well designed method of data collection improve the predictive power of the stated preference model (SPM).



Another issue is whether a respondent can adequately evaluate the hypothetical choices that are presented. This issue is concerned with the property of independence from irrelevant alternatives (IIA) of the multinomial logit models. Adamowicz et al. (1994) points out that the SPM employs the design of fractional factorial experiments to eliminate collinearity among the attributes. This statistical design orthogonalizes the absolute attribute levels, but not differences in utility. These authors point out that logit models are “difference-in-utility” models. That is, the logit parameters are defined on design matrix columns that represent differences in attribute levels for continuous attributes or contrasts in attribute levels for qualitative attributes. Thus, the addition of a constant reference alternative to each choice set results in the differences being calculated with respect to a constant, preserving the orthogonality of the design. Consequently, it is important that the default option of “no choice” is included. A final issue is that SPM may limit the number of different factors and levels that can be evaluated. Alternative methodologies are required to evaluate a wider range of factors and levels.

In the SPM model, factors with multiple levels are commonly coded using effect codes (Adamowicz et al. 1994). Effect codes restricts the coefficient estimates of all the levels in one factor to sum to zero. These authors note that effect codes are often used in analysis of designed experiments because (a) 1,0 dummies confound the alternative-specific constant with the effects of interest, whereas, effect codes orthogonalize the attribute effects to the constant; (b) effects codes simply contrast the parameter estimates with one of the levels, whereas, 1,0 dummies contrast the estimates with the constant; and (c) interactions defined from effects coded columns are orthogonal to their respective main effects and other estimable interaction effects, whereas 1,0 dummies are not. These authors argue that effects coding gives more desirable estimation properties, particularly when one is dealing with small design spaces in which there is a small number of observations relative to the number of parameters.

Revealed preference data can also exhibit discrete choices and analyses of such models have the advantage of using actual market data. However, the revealed preference data set may exhibit collinearity, resulting in violation of some statistical properties necessary for estimation. In the SPM approach, the individual choice sets that an individual respondent will encounter are generally selected so as to meet certain desirable statistical properties, specifically, attribute orthogonality (Swait and Adamowicz. 1996). This particular structure in the individual choice set minimizes problems of collinearity.

### **3.6 REVIEW OF SEMANTIC DIFFERENTIAL SCALE (SDS) METHODOLOGY**

The methodology of the semantic differential scale (SDS) approach is selected as an alternative method to supplement information on millers’ attitude towards each wheat and flour quality characteristic that is examined in the SPM survey method. The SDS component of the questionnaire asks the respondent to provide information on their perceptions of various attributes or features of a product by means of ratings described by a set of bipolar adjectives. Conventionally, a seven-level semantic differential scale with bipolar adjectives is used to evaluate respondents’ attitudes towards product attributes. This method has been used by Nagashima (1970), Papadopoulos (1994), Kim *et al.* (1996) and Kuperis *et al.* (1997).



The SDS approach is often used to develop product profiles based on consumer attitudes and product attributes and to develop total scores by which these factors can be compared. The method entails scaling preferences or behavior and probes both the direction and the intensity of respondent's attitudes towards concepts such as corporate image, brand or service image or country image (Green, Tull and Albaum, 1988). Depending on the order of scaling, relatively higher or lower ratings are taken to indicate preferred product attributes or dominant consumer behavior. For example, a respondent could be asked to rate a product's price on a scale of -3 to +3, with -3 representing "expensive" and +3 representing "inexpensive". Nagashima (1970) claimed that the SDS is an effective tool in cross-cultural and cross-linguistic settings as a standard of measure against which the different individuals can be compared. Churchill (1991) notes that the general focus of using the SDS technique to form scales has been to select an appropriate sample of adjective pairs so that a score can be generated for the object of each of the evaluation. The evaluated object can then be compared to other objects using these scores. This scale is often used in developing profiles for brands or countries, as well as developing total scores by which the objects can be compared (Churchill, 1991).

### **3.7 SUMMARY AND CONCLUSIONS**

This chapter opened with a review of literature on modeling wheat demand in Asia. The chapter also reviewed previous studies that addressed issues regarding the importance of wheat quality characteristics and the effects of country of origin on wheat marketing in Asia. Several studies indicated that differentiation in wheat marketing has increased over time and that increased focus is being placed by buyers on characteristics of different wheats. Consequently, information on millers' preferences for wheat and flour quality characteristics is required in wheat marketing. This is the purpose of this survey-based market study and the study uses stated preference method (SPM) and semantic differential scaling (SDS) approaches for this purpose. An outline of the theoretical foundation of the model that is used to assess millers' preference for wheat and flour quality characteristics is presented in this chapter. Two methodologies of data collection are then introduced and reviewed: SPM and SDS. The next chapter outlines how the SPM and SDS questionnaire are formulated and applied in Japan and South Korea.



## **4. RESEARCH METHODOLOGY**

### **4.1 INTRODUCTION**

The previous chapter reviewed studies of wheat demand in Asian markets. It also explored the theory of discrete choice and the multinomial logit model (MNL), which provides the empirical framework of this study. In order to employ the MNL, an appropriate methodology for data collection needs to be determined, based upon the nature and focus of the study. The stated preference method (SPM) is selected as the method of data analysis. The previous chapter also elaborated on the identified methodology of data collection. This chapter explains the actual procedure involved in formulation of the SPM questionnaire and data collection. It also gives a discussion of quality characteristics of wheat and wheat flour that are identified through the data collection process.

### **4.2 PROCESS OF SURVEY STUDY**

The survey process for this study involved two stages. In the first stage, preliminary investigation of previous studies and pre-survey interviews with industry experts in Japan and Korea provided guidelines for the development of the survey questionnaires. The interviews conducted during this stage involved open-ended, unstructured discussions with key informants of the milling industry in Japan and Korea. These interviews were exploratory in nature and elicited information on important quality characteristics of wheat and wheat flour. The information gathered at this stage was used in formulating the SPM and the semantic differential scale (SDS) questionnaires. When the questionnaires were developed, they were translated into Korean and Japanese. The Japanese translation was done by a graduate student at Niigata University and this was in turn checked by an industry expert in Japan. The Korean translation was done by the interviewer and checked by an industry expert in South Korea. When the initial questionnaire was developed and the translation was completed, both surveys were pre-tested to ensure that the choice sets in the questionnaire portrayed realistic ranges of quality factors. In Japan, the questionnaire was pre-tested by its application to researchers at the research lab of the Japan Flour Millers' Association and by three food quality managers in one of the Big Four milling companies. In South Korea, the questionnaire was pre-tested by application to two managers of the Korea Flour Mills' Association and three quality managers in two milling companies. Most of the food quality managers who participated in this pre-test session had twelve to eighteen years of experience in the milling business.

The second stage of the survey process involved collection of quantitative and qualitative data from millers in Japan and South Korea using the final version of the formal survey questionnaire. The survey questionnaire consisted of two separate components. The first section included the stated preference method (SPM) questionnaire and the second section consisted of the semantic differential scale (SDS) questionnaire. The SDS questionnaire was used as an alternative method to collect data on millers' ratings of wheat quality characteristics and this was considered as supplementary information to the information derived from the SPM survey.



### 4.3 PRODUCT CHARACTERISTICS AND ATTRIBUTES

The empirical application of the SPM requires combinatorial experimental designs to construct choice stimuli. In constructing the choice experiment, a number of issues and tasks are involved. These include (i) determination of factors; (ii) identification of factor levels specific to each factor; and (iii) method of questionnaire presentation to respondents. Identified factors and the levels are used to design a fractional factorial experiment with orthogonal main effects. An orthogonal fractional factorial enables us to design alternatives and choice sets simultaneously. The attribute orthogonality with main effects experimental design imposes independence between the factors and assumes that interaction effects are negligible. This ensures absence of collinearity in data, which is a desirable statistical property for the model estimation.

Generated choice experiments should mimic the actual choice situations faced by individuals as closely as possible in order to increase the validity of the SPM parameters. It is important to ensure that the levels that each characteristic takes deliver a certain degree of pragmatism. This is to say that there must be balance between what are 'realistic' levels for each factor and what are 'desirable' for them. Green and Srinivasan (1978) note that this fine line of balance improves the prima facie validity of judgement based responses.

#### 4.3.1 Identification of Price, Quality Factors and Factor Levels

Characteristics can be identified through review of relevant technical and trade literature. There are several other approaches to identify significant factors of a product and the levels of each factor. These include: (a) group interviews of buyers; (b) eliciting the 'expert judgement' of knowledgeable industry participants; (c) direct questioning of individual subjects; and (e) protocols (Cattin and Wittink, 1982). Esfahani and Stanmore (1994b) identified protein content, test weight, thousand-kernel weight, hardness, flour extraction, foreign material, unmillable material and ash content as important quality characteristics of wheat. These authors also identified flour ash, color grade, flour protein, development time, water absorption and stability as important quality characteristics of flour. As noted in Chapter 3 (section 3.2.3), country of origin was also identified as one of the important factors affecting millers' choices (Veeman 1987, Larue 1991, Wilson 1989).

In this study, combinations of three different methods were applied to identify the relevant factors and their levels. First, relevant literature on wheat trading and cereal science was reviewed to determine the factors that are most likely to be significant to millers in Japan and Korea. The expert judgement of experienced industry participants, viewed to be key informants, then was elicited by direct questioning. Documents on the analysis of wheat quality were obtained from millers and reviewed.

Interviews with industry experts and millers revealed that it is important to evaluate both wheat and wheat flour quality factors in order to gain a comprehensive understanding of milling industries in Japan and Korea. Quality characteristics of wheat have effects on both the quality characteristics of wheat flour and the final products that are processed



from wheat flour. Hence, the preferences of millers for wheat quality are largely influenced by wheat flour quality that is specified by end-users.

The price variable is included as a price change variable rather than as an actual price since it is difficult to obtain the actual price information. Since price is one of the major factors influencing millers' purchase decision of imported wheat, a range of actual price levels that do not effectively reflect current market condition may result in bias in millers' purchase decisions. Initially the same factor levels were applied for the factor of price in both the Korean and Japanese versions of the SPM questionnaires. Initially the price factor was specified at four levels: 10 percent decrease in the price of wheat, compared to the last purchase; 5 percent decrease in the price; no change in the price; and 5 percent increase in the price. However, Japanese respondents indicated that this range of price change was sufficiently wide that most respondents would find the hypothetical scenario to be unrealistic. Since the resale prices paid for imported wheat by Japanese millers have a substantial mark-up added by the Japan food agency (JFA), the millers did not expect and perceived that they could not afford a change in the price of wheat of more than 2 percent. Therefore, the levels of the price factor for the Japanese SPM questionnaire were changed to: 2 percent down in the price from the previous purchase price; 1 percent down in the price; no change in the price; and a one percent increase in the price.

#### ***4.3.2 Categorization of Wheat Classes and Wheat Flour***

To determine the important quality characteristics (factors) of wheat and flour and their levels, the first step is to understand the categorization of wheat classes and of wheat flour that are used in Japan and South Korea. Wheat classes are categorized on the basis of wheat variety (type) and wheat protein characteristics. The standard set of wheat characteristics, on which categorization of wheat classes is typically based, include: protein content, moisture content, test weight, thousand-kernel weight, unmillable material, dockage level, ash content, amylase activity and flour extraction. Wheat flour is commonly graded based on protein content, moisture content, ash content, amylograph (Interview, 1999). The selected factors and their levels of each wheat class and flour category are described in details in sections 4.3.3 to 4.3.7.

Japan and Korea have slightly different schemes for categorization of wheat class and wheat flour grading (Wheat and Wheat Flour 1999). In Japan, four categories are commonly used to distinguish wheat classes. These are hard wheat, semi-hard wheat, medium wheat and soft wheat. In South Korea, three categories are used to distinguish wheat classes. These are hard wheat, medium wheat and soft wheat (Table 4.1 and 4.2).

In terms of protein content and variety, Japan's semi-hard wheat and Korea's hard wheat are similar, while medium and soft wheat in both markets are defined with identical wheat quality characteristics (Interview, 1999). Therefore, hard wheat in Korea is termed as "semi-hard wheat" throughout this research discussion of the study in order to avoid confusion that may be created due to the discrepancy in the terminology of wheat classes in these two markets. In this study, wheat classes and wheat flours used in noodle processing are of particular interest. In Japan, hard wheat, semi-hard wheat and medium



wheat classes are used to produce noodle flours, while in Korea, semi-hard wheat, medium wheat and soft wheat classes are used to produce noodle flours.

For wheat flour grading, based on end-usage, Japan uses four categories to differentiate wheat flour for noodle processing. These are Udon flour, dry-noodle flour, fresh Ramen flour and Instant Ramen flour (Table 4.2). In Korea, there are three categories for noodle flours: Udon flour, dry-noodle flour and Instant Ramen flour (Table 4.1). Thus, demand for fresh Ramen flour is virtually non-existent in the Korean market. Hence, different wheat classes and different types of wheat flour are selected as product categories for each of the two selected markets. The product categorizations that are used in Japan and South Korea were used in developing different specifications of the SPM models that were applied in each country. The important factors and their levels of each noodle category in Japan and South Korea are reported in section 4.3.5.

#### ***4.3.3 Organization of the SPM Questionnaire***

The pre-survey interviews indicate that the quality characteristics recognized to be important in determining the suitability of wheat for noodle application include protein content, test weight, falling number, dockage level, ash content. The most important quality characteristics of wheat flour were described by millers as ash content, color and amylograph. Based on the initial discussions with industry representatives, the SPM questionnaire was subdivided into three sections. The first section of the questionnaire was divided into three separate sub-sections, each of which is directed at three wheat classes. Therefore, the first section of the SPM questionnaire for the Korean market included separate questions on semi-hard wheat, medium wheat and soft wheat choices (Table 4.1), while, in Japan, the questionnaire included separate questions for hard wheat, semi hard wheat and medium wheat choices (Table 4.2).

The second section of the SPM questionnaire was divided into three sub-sections for the Korean market and four sub-sections for the Japanese market. The Korean questionnaire included separate questions on Udon flour, dry noodle flour and instant Ramen flour choices (Table 4.1). The Japanese questionnaire contained separate questions on Udon flour, dry noodle flour, fresh Ramen flour and instant Ramen flour choices (Table 4.2).

The third section of the SPM questionnaire assesses the effects of the wheat quality factors such as protein content, country of origin, dockage level and price on the probability of miller's wheat choices. These four factors are commonly included in purchase contracts of wheat imported into Japan and South Korea. The focus of this particular section of the survey is to enable evaluation of the relevant wheat choices that relate to sourcing from different suppliers. Since this section also examines the effects of wheat quality factors, the product categorization in the third section of the SPM questionnaire is identical to the first section of the SPM questionnaire, which evaluates the effect of different set of wheat quality factors. For the Japanese market, the three product categories include hard wheat, semi-hard wheat and medium wheat classes, and for the Korean market, the three product categories include semi-hard wheat, medium wheat and soft wheat classes. (Figure 4.1 and 4.2).



Division of the survey questionnaire into three sections was undertaken in order to reduce potential problems of violating the assumption of the property of independence of the MNL model from irrelevant alternatives (IIA). This assumption proposes that if some alternatives are removed from a choice set, the relative choice probabilities from the reduced choice set are unchanged. However, if alternative wheat classes in a choice set are perceived by the respondents to be similar, wheat classes may be treated as a single alternative resulting in violation of the IIA assumption. Some of the wheat quality characteristics are highly correlated in terms of their functions. For instance, there is an inverse relationship between flour yield and protein content and a positive relationship between flour yield and ash content. Therefore, ash content and protein content are inversely related, although the precise nature of this tradeoff has not been well quantified biologically (Simmonds, 1989). Hence, inclusion of these two factors together in a choice set could create the problems of violating the IIA assumption. Luce (1959) suggested that the validity of choice axioms depends on the structure of the choice set and that the validity of the choice axioms should be restricted to choice sets with “distinct” alternatives.

In summary, the first section of the SPM questionnaire explores intrinsic wheat quality characteristics, and evaluates the effects of the wheat quality factors on choices of three different wheat classes. The second section of the SPM questionnaire looks at quality characteristics of wheat flour, and assess the effects of the flour quality factors on choices of three (in the Korean case) or four (the Japanese case) flour products. The last section of the SPM questionnaire evaluates those wheat quality characteristics which apply as the terms of purchase contracts. This third section examines the effects of particular wheat quality factors that differ from the factors that are identified in the first section. For each of the three different sections of the questionnaire, the different product factors and levels have to be identified, reflecting the features that three sets of choice experiments are developed. These three sub-sets of SPM questions arose since appropriate choice variables and associated choice sets were sufficiently different for different classes of wheat and noodle types. Division of the SPM analysis into sub-models that are reflected in the division of the questionnaire into sub-sections relates to the appropriateness of choice sets and models.

#### ***4.3.4 The First Section of the SPM Questionnaire***

Despite some differences in categorizations of wheat class and wheat flour in Japan and South Korea as outlined above, preliminary interviews indicated that millers in both markets each viewed the same specific factors to be of importance. However, as discussed in section 4.3.1., the specifications by millers of particular levels for some factors was specified are different in the two different markets (Tables 4.3 to 4.6).

The first section of the SPM questionnaire focuses on analysis of the wheat quality factors of ash content, falling number and test weight (Tables 4.3 and 4.4). There are three SPM experiments in the first section of the questionnaire. Each experiment includes choice sets combining different levels of four factor levels that are identified above and focus on a particular wheat class. For instance, the first SPM experiment of the questionnaire includes choice sets of semi-hard wheat class for the Korean market. The



three SPM experiments are included in the first section of the questionnaire in an exact order from hard wheat, semi-hard wheat and medium wheat for the Japanese version. For the Korean version, the order of the three experiments is semi-hard wheat, medium wheat and soft wheat.

Simmonds (1989, p79) states that ash is composed of inorganic material present predominantly in the outer layers of the grain. Simmonds notes that the ash content of wheat flour is a good indication of milling quality, since a high ash content indicates significant contamination with aleurone cells and bran during the milling operation. Falling number is an index of amylase activity (Table 4.3). As the index increases, higher amylo-viscosity flour can be produced. In turn, the higher amylo-viscosity flour will give desirable springy and smooth texture to final noodle products (CIGI, 1993). Thus, higher index numbers of the falling number indicates desirable milling and flour dough characteristics of wheat.

Test weight measures the density of wheat kernels (Table 4.4). In general, higher test weights lead to higher yields of flour from milling the wheat and thus higher grades and prices since flour yield is important. The higher the flour yield, the more profitable will be the wheat (Walburger et al., 1999). Hence, millers are interested in purchasing wheat with higher test weights. Price was included as the fourth factor in the first section of the SPM questionnaire.

#### ***4.3.5 The Second Section of the SPM Questionnaire***

For the second section of the SPM questionnaires which focuses on wheat flour quality factors, four attributes, identified to be significant are price, color, ash content and amylograph (Table 4.5). There are three SPM experiments for this section. The first experiment includes questions on udon flour and the second experiment includes questions on dry noodle flour. The third experiment contains questions on Ramen flour. The Japanese version of the SPM questionnaire includes an additional product category for the second section. The fourth experiment includes questions on fresh Chinese noodle flour in the Japanese case. Low ash content and desirable color are critical in determining the quality of wheat flour (CIGI, 1993). The nature of flour color is measured in three ways: L value indicating brightness of the flour; A value indicating redness; and B value indicating yellowness. Conventionally the L value is used to evaluate the color quality of wheat flour (CIGI, 2000). The amylograph measure is an indicator of enzymic activity in wheat flour and reflects the elasticity and texture of wheat flour. As the measure of amylograph increases, the amylo-viscosity of the wheat flour increases, giving desirable texture and elasticity to noodle flour.

#### ***4.3.6 The Third Section of the SPM Questionnaire***

In the third section of the SPM questionnaire, the wheat quality factors of price, protein content, and country of origin and dockage level are assessed (Table 4.6). These four quality factors are commonly specified in the terms of wheat purchase contracts. Inclusion of price as one of the factors postulated to determine of choices in each section enables the evaluation of millers' responses to changes in price. In Asian countries, wheat flour is mostly classified as strong, medium and soft wheat flour based on protein content



(CIGI, 1993). In Canada, higher protein wheats have qualified for higher prices since high protein content translates into several desirable traits such as high loaf volume, good water absorption and loaves with good keeping qualities for bread wheat (Walburger et al. 1999). Thus, protein content is often cited to be the single most important factor in determining grade and price of wheat and wheat flour. Protein content is an important guide to wheat quality because it influences the quality of the finished product, determines the proportion of cheaper, poorer quality wheat that can be accommodated in a blend, and in some cases, affects the quantity of finished product that can be produced from a given quantity of flour (Stanmore and Esfahani, 1994a). Dockage, measured as a percent of product weight, is an indicator of contamination of wheat by non-wheat seeds. The dockage level is usually specified in the terms of the purchase contract, and can be negotiated in the purchasing contract.

#### ***4.3.7 Determination of Factor Levels and Construction of Choice Sets***

Stated preference models are often referred as “experimental or stated choice analysis”. In experimental choice analysis, hypothetical data are analyzed instead of observational data. The hypothetical choice sets that are developed in this study involve stated choices in which the choices are described by bundles of attribute values associated with wheat and flour quality characteristics. In order to design the choice sets, a set of factors affecting millers’ choice of wheat and flour was elicited in the pre-survey stage. The pre-survey interviews identified four factors in each sub-set of the SPM questionnaire (Tables 4.1 and 4.2). Each factor in each sub-set is defined at four different levels (Tables 4.3 to 4.6). The four factor levels for each factor are discrete and used to create the choice sets. The set of factors and levels displayed in Tables 4.1 to 4.6 can be viewed as setting the space to be spanned in the choice experiment, and the problem of choice set construction can be viewed as sampling from the universe of possible pairs of two alternatives (Adamowicz et al. 1994).

The number of alternatives in choice sets is determined by the nature of the research problem, experimental design technology and limits to human cognition. Bastell and Louviere (1991) noted that it is difficult to design practical choice experiments involving more than four to six choice alternatives that can be administered in field settings unless the number of attributes associated with each alternative is small. Hence, in this study choice sets of three alternatives are constructed, and the third alternative is non-varying between choice sets. This is used as a constant reference to ensure that the parameter estimates have a common origin and scale unit (Adamowicz, et al 1994; Bastall and Louviere, 1991). Louviere (1988) explains that the base alternative acts as a constant subtracted from the utilities of the other alternatives.

The size of a choice experiment is a function of the number of attributes to be varied in association with each choice alternative. With four attributes at four levels, an orthogonal fractional factorial array yielded 32 choice sets for each product. In the Korean market experiments, there are three product categories for each model. In the first and third section of the SPM questionnaire, three product categories are semi-hard wheat, medium wheat and soft wheat categories and in the second section of the SPM questionnaire, three product categories are identified as Udon flour, dry noodle flour and Ramen flour.



Together nine different product categories are generated for the Korean SPM questionnaire, with 32 choice sets for each product. A complete set of choice stimuli includes 288 choice sets to be evaluated.

In the case of the Japanese flour milling industry, there are four product categories in the second section of the SPM questionnaire (Table 4.2 and Table 4.5). Hence, ten different products have to be assessed in total. With 32 choice sets for each product, the complete design includes 320 choice sets to be evaluated for the Japanese survey. Respondent burden precludes asking any respondent to answer the full set of 288 or 320 choice stimuli in one interview. Hence, it is necessary to block the set of questions to be applied into more manageable sets of questions that may be presented to individuals. Each respondent responds to different choice sets, and the different blocks can be concatenated to estimate aggregate models.

From each SPM question respondents chose from two product alternatives based on descriptions of the product in terms of specific levels of attributes (alternative A and alternative B) or they could choose alternative C, a non-choice option (Figure 4.1). Alternative A and alternative B carry different profiles of the product, based on the specified factors, and alternative C, the non-choice option, provides a “base” alternative by setting the origin of the utility scale (Louviere, 1988). The final experimental design consisted of four blocks for each product. Each block consisted of eight choice sets with each choice set consisting of three alternatives. This resulted in each respondent in South Korea answering 72 SPM questions and each respondent in Japan answering 80 SPM questions.

#### **4.4 DEVELOPMENT OF THE SDS QUESTIONNAIRE**

The semantic differential scale (SDS) survey questionnaire was designed using the factors and the levels determined for the SPM survey questionnaires. Questions in the SDS questionnaire are subdivided into three groups. The first part of these question sets was directed at evaluation of wheat quality. Six questions were asked relating to wheat quality. The second part of the SDS questionnaire focuses on evaluation of wheat flour quality. In this section, eight questions were included that are relevant to wheat flour quality. The third part of the SDS questionnaire includes five questions that evaluate promotional activities by exporters.

The third section of the SDS questionnaire in this study explores Korean millers' attitudes towards products from three different countries of origins of wheat. Since the bipolar scaling method is effective when the scaling preference is to indicate preferred product attributes among products that are from a different country of origin, the bipolar scaling method is applied to the third section of the SDS questionnaire. The mean scores for three country origins (the U.S., Canada and Australia) can be calculated to indicate the relative strength of respondents' preferences for supplies from each exporting nation (Figure 4.2).

However, for quality attributes which are measured on a cardinal scale (i.e. protein content), the bipolar scaling method is not an effective means to derive respondents'



preferences since the mean value on the bipolar scale does not translate into a numeric value of the quality attribute. For instance, suppose that the mean score of the response on a scale with respect to protein content on the bipolar scale that is specified between high and low for semi-hard wheat is higher than that for the medium wheat. This merely indicates that the respondents prefer a higher level of protein content for the semi-hard wheat relative to the medium wheat, but does not show a specific level of protein content that is preferred for each wheat class. Millers make purchasing decisions based on wheat quality attributes that are specified with numeric values. Consequently, the relative values of a quality attribute indicated by the mean score rating of respondents on a bipolar scale for each wheat class, do not portray sufficient information on millers' preferences. The first and the second sections of the SDS questionnaire, which evaluate preferences on quality of wheat and wheat flour, are modified so that the seven scales on each question are specified with numeric values that are relevant to each wheat class. This allows elicitation of millers' preferences for each factor in terms of specific numeric values (Figure 4.3).

The first section of the SDS questionnaire directs questions oriented to respondents' assessments of the importance of protein content, ash content, moisture content, falling number, test weight and dockage level of wheat. The second section of the SDS questionnaire includes questions to evaluate the importance of the wheat flour quality characteristics of color, flour ash content, amylograph, flour protein content, moisture content, stability, elasticity and water absorption. The last section of the SDS questionnaire includes questions on aspects of service among three exporters such as consistency of supply, reliability, service/assistance, variety of products and quality of technical information. Each of the factors viewed to be of importance in millers' preferences and included in the SPM questionnaire were also specified in the form of questions in the SDS sub-survey. It was anticipated that applying identical factors and levels in the two methods would allow comparison of the results from two approaches. The minimum and maximum levels of each factor that are used in the SPM questionnaire (Table 4.3 to 4.6) are also used in the SDS questionnaire. The minimum and maximum levels of each factor are designed as seven scales for the first and the second section of the SDS question set (Figure 4.3).

#### 4.5 SURVEY METHOD AND STUDY AREA

There are various methods of conducting surveys: mail back methods, personal interviews, and telephone interviews. This study selected the personal interview method to conduct the survey. This allowed the interviewer to explain the purpose of the study and to present the survey questions to the respondents precisely and completely. In this approach, the interviewers have more flexibility than in other types of survey applications. The interviewers can set up interviewing conditions to assure that the desired respondents are replying and that respondents understand the task. This minimizes inaccuracies in the collected data. Heaner *et al.* (2000) suggest that the in person setting of the survey generate more thought-out and reliable responses than mail back methods. Thus, the method of personal interviews applied in this survey could generate superior data quality and this may lead to the development of superior choice models.



Figure 4.3 shows a typical choice set. Since this study was applied in two markets, the original choice sets were translated and applied in Japanese and Korean languages.

#### ***4.5.1 Data Collection in South Korea***

In Korea, there are eight major millers in the flour milling industry and their milling plants are scattered in three major port areas. These plants are located in six different cities: Seoul, Inchon, Busan, Suwon, Kwangju and Mokpo. A total of 35 respondents from the eight milling companies participated in the interviews and 23 provided complete answers to the choice experiment. Most of the respondents are quality managers and purchase managers for their flourmills and most of them have at least ten years of experience in the milling business. In arranging interviews with these millers, the Korea FlourMills Industrial Association (KOFMIA) assisted the interviewer by making the formal requests and arranging interview schedules by telephone. The survey interviews in South Korea were administered through the year of 1999.

#### ***4.5.2 Data Collection in Japan***

In Japan, there are 134 flour milling companies, physically located across the country. Among these, the largest 25 milling companies account for approximately 85 percent of the sector based on sales. Hence, representatives of these 25 milling companies were visited to gather the data. The companies are located in eight major port cities: Tokyo, Osaka, Nambu, Kyoto, Nagoya, Fukuoka, Kumamoto and Chiba. A total of 57 mill representatives were interviewed and 41 of these answered the survey questionnaire. Since the millers are scattered throughout Japan, each local market has its own flour millers' association. To contact millers in local areas, the Canadian Wheat Board (CWB) Tokyo office, which has close connections both with the millers' associations and with major milling companies, made formal requests by letters and telephone calls. The surveys in Japan were also conducted through the year of 1999.

### **4.6 SUMMARY AND CONCLUSIONS**

The objective of this chapter was to outline the development of the survey questionnaires. This chapter reported the process of survey administration and identified important factors and factor levels, which were used in developing the survey questionnaire. Detailed information on determined factors and factor levels were presented and the process of construction of the SPM questionnaire was reported in this chapter. This chapter also explained the process involved in data collection and described the study areas in Japan and South Korea that were covered by the interviewer.



**Table 4.1 Factors/ Product Types specified for the SPM Choice Experiment for Korean Market**

| Product Types in Each Section /a, c |                  |   |
|-------------------------------------|------------------|---|
| Wheat                               | Flour            | Wheat<br>relating to Trade Contract Terms |
| Semi-hard wheat                     | Udon flour       | Semi-hard wheat                           |
| Medium wheat                        | Dry noodle flour | Medium wheat                              |
| Soft wheat                          | Ramen flour      | Soft wheat                                |
| Quality Attributes in Each Section  |                  |   |
| Wheat                               | Flour            | Wheat<br>relating to Trade Contract Terms |
| Price                               | Price            | Price                                     |
| Ash content                         | Color            | Protein content                           |
| Falling number                      | Ash content      | Country of origin                         |
| Test weight                         | Amylograph       | Dockage                                   |

/c The first choice experiment includes 32 questions on semi-hard wheat class for the Korean market. The second choice experiment includes 32 questions on medium wheat class, while the third choice experiment includes 32 questions on soft wheat class. For the Japanese market, the first choice experiment has 32 questions on hard wheat class and the second choice experiment has 32 questions on semi-hard wheat class. The last choice experiment in the Japanese questionnaire includes 32 questions on medium wheat class.

**Table 4.2 Factors/ Product Types specified for the SPM Choice Experiment for Japanese Market**

| Product Types in Each Section /a, b |                            |   |
|-------------------------------------|----------------------------|---|
| Wheat                               | Flour                      | Wheat<br>relating to Trade Contract Terms |
| Hard wheat                          | Udon flour                 | Hard wheat                                |
| Semi-Hard wheat                     | Dry noodle flour           | Semi-Hard wheat                           |
| Medium wheat                        | Ramen flour                | Medium wheat                              |
|                                     | Fresh Chinese-noodle Flour |   |
| Quality Attributes in Each Section  |                            |   |
| Wheat                               | Flour                      | Wheat<br>relating to Trade Contract Terms |
| Price                               | Price                      | Price                                     |
| Ash content                         | Color                      | Protein content                           |
| Falling number                      | Ash content                | Country of origin                         |
| Test weight                         | Amylograph                 | Dockage                                   |

/a Categorization of wheat classes and flour products and factors for each category are determined based on information from the pre-survey interviews.

/b Millers in South Korea divide imported wheat into three categories: hard wheat, medium wheat and soft wheat, while millers in Japan divide imported wheat into four categories: hard wheat, semi-hard wheat, medium wheat and soft wheat. The hard wheat category from South Korea has a similar quality specification to semi hard wheat category in Japan. Since this study includes comparison of these two markets, the hard wheat category of South Korean market is described as “semi-hard” wheat to avoid confusion. The rest of this thesis uses the term, semi-hard wheat to refer hard wheat category in South Korea.



**Table 4.3 Descriptions of Factor Attributes and Factor Levels in Wheat Quality Survey (Section 1 of the SPM Questionnaire)**

| Attribute                | Definition   |                        |
|--------------------------|--|------------------------|
| <b>Ash content /a</b>    | <p>Ash is composed of inorganic material present predominantly in the outer layers of the grain. The ash is expressed on an 11% moisture basis for wheat and 13.5% moisture basis for flour.</p> <p>The ash content of flour is a good indication of milling quality, since a high ash content indicates significant contamination with aleurone cells and bran during the milling operation.</p>  |                        |
| Wheat type/b             | Factor levels in Japan   | Factor levels in Korea |
| Hard Wheat Class         | 1.90% to 1.45%   | N/A                    |
| Semi-hard Wheat Class    | 1.85% to 1.45%   | 1.90 % to 1.45%        |
| Medium Wheat Class       | 1.85% to 1.45%   | 1.85 % to 1.45%        |
| Soft Wheat Class         | N/A  | 1.85% to 1.45%         |
| <b>Falling Number /a</b> | <p>A test to measure the amount of amylase released and the susceptibility of the starch in the sample to enzymic attack.</p> <p>The falling number test measures the rate at which a weight falls through a starch gel or flour paste prepared under standardized conditions. A high falling number value represents low amylase activity.</p> <p>Falling numbers of 250 seconds or above are indicative of sound wheat, the exact value depends on the variety under test and the growing conditions.</p> <p>These features relate to the texture of dough and the noodle products</p> |                        |
| Wheat type /b            | Factor levels in Japan   | Factor levels in Korea |
| Hard Wheat Class         | 250 to 380   | N/A                    |
| Semi-hard Wheat Class    | 250 to 380   | 250 to 380             |
| Medium Wheat Class       | 250 to 380   | 250 to 380             |
| Soft Wheat Class         | N/A  | 250 to 380             |

/a Simmonds, 1989 p79

/b the factor levels for each wheat class are determined based the pre-survey on interviews.



**Table 4.4 Descriptions of Factor Attributes and Factor Levels in Wheat Quality Survey (Section 1 of the SPM Questionnaire)**

| Attribute             | Definition  |                        |
|-----------------------|---|------------------------|
| <b>Test Weight</b> /a | <p>Test weight is a measure of volume of grain and is expressed in kilograms per hectolitre or in pounds per bushel.</p> <p>The test weight indicates growing and harvesting conditions of wheat. Very low test weight is associated with sub-optimum growing and harvesting conditions, and such conditions can cause shrinkage, bleaching and subsequent loss of grade.</p> |                        |
| Wheat type /b         | Factor levels in Japan  | Factor levels in Korea |
| Hard Wheat Class      | 73 to 84  | N/A                    |
| Semi-hard Wheat Class | 75 to 84  | 73 to 84               |
| Medium Wheat Class    | 75 to 84  | 75 to 86               |
| Soft Wheat Class      | N/A   | 75 to 84               |
| <b>Price level</b>    | <p>The price variable is included as a price change rather than as an actual price.</p>   |                        |
| Wheat type /b         | Factor levels in Japan  | Factor levels in Korea |
| Hard Wheat Class      | 2% down to 1% up  | N/A                    |
| Semi-hard Wheat Class | 2% down to 1% up  | 10% down to 5% up      |
| Medium Wheat Class    | 2% down to 1% up  | 10% down to 5% up      |
| Soft Wheat Class      | N/A   | 10% down to 5% up      |

/a Brent E. Futz, 1993 p 1

/b the factor levels for each wheat class are determined based on interviews of the pre-survey session



**Table 4.5 Descriptions of Factor Attributes and Factor Levels in Flour Quality Survey (Section 2 of the SPM Questionnaire)**

| Attribute                  | Definition  |                        |
|----------------------------|---|------------------------|
| <b>Color grade /a</b>      | <p>The color grade of a flour is a valuable measure of quality since it reflects two important aspects of milling quality: (a) the freedom of the resulting flour from finely divided bran specks, i.e. the ease with which the aleurone and outer layers can be removed from the endosperm, and (b) the actual color of the endosperm.</p> <p>The reflection of light from flour at a wavelength where there is minimum interference from yellow xanthophyll measures the color grade. There are several different instruments that measure the color grade. In this study, the value of the color grade (L value) is based on the measurement from Minolta colorimeter.</p> |                        |
| Wheat Flour type /b        | Factor levels in Japan  | Factor levels in Korea |
| Udon flour                 | 89 to 95  | 89 to 95               |
| Dry noodle flour           | 89 to 93  | 89 to 95               |
| Fresh Ramen flour          | 89 to 93  | N/A                    |
| Instant Ramen flour        | 90 to 94  | 89 to 95               |
| <b>Flour Ash content/c</b> | <p>As explained in Table 4.3, Ash content is an indicator of flour quality. Ash has a positive relationship with flour yield since extraction of higher yields of flour will give higher ash content of flour.</p>  |                        |
| Wheat Flour type /b        | Factor levels in Japan  | Factor levels in Korea |
| Udon flour                 | 0.50% to 0.35%  | 0.38% to 0.32%         |
| Dry noodle flour           | 0.55% to 0.35%  | 0.45% to 0.38%         |
| Fresh Ramen flour          | 0.50% to 0.35%  | N/A                    |
| Instant Ramen flour        | 0.50% to 0.35%  | 0.45% to 0.38%         |
| <b>Amylograph/c</b>        | <p>Amylograph is a test for amylase activity of flour. Higher value of amylograph indicates low level of amylase activity, which is desirable property of flour quality.</p>  |                        |
| Wheat Flour type /b        | Factor levels in Japan  | Factor levels in Korea |
| Udon flour                 | 250 to 500  | 700 to 1200            |
| Dry noodle flour           | 250 to 500  | 500 to 1200            |
| Fresh Ramen flour          | 250 to 500  | N/A                    |
| Instant Ramen flour        | 250 to 500  | 500 to 1200            |

/a Simmonds, 1989 p40

/b the factor levels for each wheat class is determined based on interviews of the pre-survey session.

/c Simmonds, 1989 p79



**Table 4.6 Descriptions of Factor Attributes and Factor Levels in Second Wheat Quality Survey (Section 3 of the SPM Questionnaire)**

| Attribute                   |  | Definition  |
|-----------------------------|--|---|
| <b>Protein Content /a</b>   |  | Protein is a key quality factor that buyers of wheat normally expect a minimum guaranteed protein content to suit their particular end use (Tipples, 1986).   |
|                             |  | Protein is an important guide to wheat quality since it affects the gluten strength of dough and the quality of the finished product. The quantity of protein is used as a proxy for trading since the quality of protein is not easily measured (Wilson, 1989).  |
| Wheat type /b               | Factor levels in Japan                 | Factor levels in Korea  |
| Hard Wheat Class            | 12.0% to 14.0%                         | N/A   |
| Semi-hard Wheat Class       | 10.2% to 12.8%                         | 10.8% to 12.8%  |
| Medium Wheat Class          | 9.5% to 11.5%                          | 9.5% to 11.5%   |
| Soft Wheat Class            | N/A                                    | 8.5% to 10.0%   |
| <b>Country of Origin /b</b> |  | Country of origin may reflect the cumulative effects of a country's entire production/marketing system including the grading system, breeding programs, and cargo consistency etc (Wilson, 1989).   |
| Wheat type /b               | Factor levels in Japan                 | Factor levels in Korea  |
| Hard Wheat Class            | The U.S., Canada, Australia, domestics | N/A   |
| Semi-hard Wheat Class       | The U.S., Canada, Australia, domestics | The U.S., Canada, Australia, domestics  |
| Medium Wheat Class          | The U.S., Canada, Australia, domestics | The U.S., Canada, Australia, domestics  |
| Soft Wheat Class            | N/A                                    | The U.S., Canada, Australia, domestics  |
| <b>Dockage level /c</b>     |  | Dockage level measures the cleanliness of the grain. The dockage level indicates the amount of unmillable material and foreign matter that exist among the grains. The dockage level is a deductible in transactions and the removal of dockage depends on the incentives in the market (Wilson, 1989). |
| Wheat type /b               | Factor levels in Japan                 | Factor levels in Korea  |
| Hard Wheat Class            | 0.2% to 0.8%                           | N/A   |
| Semi-hard Wheat Class       | 0.2% to 0.8%                           | 0.2% to 0.8%  |
| Medium Wheat Class          | 0.2% to 0.8%                           | 0.2% to 0.8%  |
| Soft Wheat Class            | N/A                                    | 0.2% to 0.8%  |

/a Brent E. Futz, 1993 p 2, Tipples, 1986 p500-511.

/b the factor levels for each wheat class are determined based on interviews of the pre-survey session

/c Simmonds, 1989 p69



**Figure 4.1 Examples of Stated Preference Method (SPM) Questions**

**Section 1: Semi-hard wheat**

**(an Example Question of the First SPM Experiment) /a, d**

Assume that the following alternatives are the only ones on your next order for medium wheat. Would you choose A or B or would you choose neither?

| Product Attribute | Alternative A                    | Alternative B                     | Alternative C               |
|-------------------|----------------------------------|-----------------------------------|-----------------------------|
| Price             | 5% less than previous price paid | Same price as previous price paid | Neither alternative A nor B |
| Ash content       | 1.90%                            | 1.45%                             |                             |
| Falling number    | 300                              | 380                               |                             |
| Test weight       | 73                               | 84                                |                             |
| I would choose    | ( )                              | ( )                               | ( )                         |

/a the first SPM experiment in the first section of the survey includes 32 questions on semi-hard wheat.

**Section 2: Dry noodle Flour**

**(an Example Question of the Fourth SPM Experiment) /b, d**

Assume that the following alternatives are the only ones on your next order for medium wheat. Would you choose A or B or would you choose neither?

| Product Attribute | Alternative A                    | Alternative B                     | Alternative C               |
|-------------------|----------------------------------|-----------------------------------|-----------------------------|
| Price             | 5% less than previous price paid | Same price as previous price paid | Neither alternative A nor B |
| Ash content       | 0.45%                            | 0.38%                             |                             |
| Color             | 93                               | 95                                |                             |
| Amylograph        | 960                              | 960                               |                             |
| I would choose    | ( )                              | ( )                               | ( )                         |

/b the fourth SPM experiment in the second section of the survey includes 32 questions on dry noodle flour.

**Section 3: Trade, Medium wheat**

**(an Example Question of the Eighth SPM Experiment) /c, d**

Assume that the following alternatives are the only ones on your next order for medium wheat. Would you choose A or B or would you choose neither?

| Product Attribute | Alternative A                    | Alternative B                     | Alternative C               |
|-------------------|----------------------------------|-----------------------------------|-----------------------------|
| Price             | 5% less than previous price paid | Same price as previous price paid | Neither alternative A nor B |
| Protein level     | 10.8%                            | 11.5%                             |                             |
| Country of origin | Canada                           | Australia                         |                             |
| Dockage           | 0.4                              | 0.6                               |                             |
| I would choose    | ( )                              | ( )                               | ( )                         |

/c the eighth SPM experiment in the third section of the survey includes 32 questions on medium wheat class.

/d the SPM questionnaire is formulated based on the factor levels for each wheat class that are elicited from interviews of the pre-survey session



**Figure 4.2 Example of Semantic Differential Scale (SDS) Question:  
Evaluation of Quality of Service and Promotional Activities**

Please indicate the relative strength of three nations in terms of reliability by checking on three separate scales for each nation. /b

| Attribute   |           | Excellent |   |   |   |   |   | Poor |
|-------------|-----------|-----------|---|---|---|---|---|------|
| Reliability | The U.S.  |           | : | : | : | : | : |      |
|             | Canada    |           | : | : | : | : | : |      |
|             | Australia |           | : | : | : | : | : |      |

/b the SPM questionnaire is formulated based on the factor levels for each wheat class that are elicited from interviews of the pre-survey session

**Figure 4.3 Example of Semantic Differential Scale (SDS) Question:  
Evaluation of Wheat Quality**

Please indicate your preferred level of protein content by checking on three separate scales for each wheat class. /c

| Attribute           |                 |      |      |      |      |      |           |
|---------------------|-----------------|------|------|------|------|------|-----------|
| Protein Content (%) |                 | 12.0 | 12.4 | 12.8 | 13.2 | 13.6 | 14.0 14.2 |
|                     | Semi-hard wheat | :    | :    | :    | :    | :    | :         |
|                     |                 | 10.5 | 11.0 | 11.5 | 12.0 | 12.5 | 13.0 13.5 |
|                     | Medium wheat    | :    | :    | :    | :    | :    | :         |
|                     |                 | 9.0  | 9.5  | 10.0 | 10.5 | 11.0 | 11.5 12.0 |
|                     | Soft wheat      | :    | :    | :    | :    | :    | :         |

/c the SPM questionnaire is formulated based on the factor levels for each wheat class that are elicited from interviews of the pre-survey session



## 5. EMPIRICAL RESULTS FOR THE SOUTH KOREAN MARKET

### 5.1 INTRODUCTION

The SPM and SDS data are collected following the procedure outlined in Chapter 4. Based on the data collected by this process, separate discrete choice models are estimated as the responses of millers in each nation. This chapter reports on results of the estimation of the MNL model for the South Korean flour milling industry. Findings from the analysis of the semantic differential scale (SDS) data for the Korean respondents are collected and compared to the results from the stated preference method (SPM). The estimated coefficients of the SPM models in Korean market provided statistical information on the preferred levels of the various factors expressed by millers in South Korea. From these responses, the preferred product profiles for each wheat class and wheat flour category are derived. The preferred product profiles are compared with the wheat classes that are currently marketed in South Korea by three major exporters: the U.S., Australia and Canada. The comparison of the preferred profiles of product characteristics with the characteristics of the currently marketed products can be taken to reflect the effectiveness of each major exporter's efforts to sell wheat designed for the South Korean wheat market.

### 5.2 MODEL SPECIFICATION OF THE MNL MODELS

Three separate MNL models are developed and the SPM data were collected in three sections of the questionnaire based on this classification. The first MNL model includes three SPM experiments on semi-hard wheat, medium wheat and soft wheat classes. Data on three experiments are combined to construct one MNL model. This allows examinations of coefficients across three experiments. For instance, the estimated coefficients of factor levels on semi-hard wheat (the first SPM experiment) could be cross-tested with the coefficients of factor levels on medium wheat (the second SPM experiment) using Wald test. In another word, the variance-covariance information of three SPM experiments data is utilized at maximum by estimating three sets of data together. The first section of the questionnaire assesses the effects of selected wheat quality characteristics on the probability of miller's wheat choices among different wheat classes. These quality factors are ash content, falling number and test weight. Price is also included as one of the variables in this model. The second model use data from the second section of the questionnaire. This section is directed at evaluation of the effects of wheat flour quality factors such as flour ash content, color, amylograph and price on probability of millers' choices of flour. The third model is tested on data collected in the third section of the questionnaire. This section examines the effects of another selected set of wheat quality factors. These are specified as protein content, country of origin, dockage level and price.

In total, three separate MNL models are estimated to evaluate Korean millers' wheat and flour choice behavior. The first model (Model I, eq 5.2) estimates the effects of the intrinsic wheat quality factors on three different wheat classes: semi-hard, medium and soft wheat classes (Table 4.1). The second model (Model II, eq 5.3) estimates the effects of the four wheat flour quality factors on choices of three wheat flour products: Udon flour, dry noodle flour and instant Ramen flour (Table 4.1). The third model (Model III,



eq 5.4) estimates the effects of wheat quality factors which are conventionally included in purchase contracts (Table 4.1). In summary, Models I and III both evaluate millers' preferences for wheat quality characteristics for three wheat categories, while Model II evaluates millers' preference for wheat flour quality characteristics for three noodle flour categories.

The general specification of the indirect utility function is:

$$U_t(A) = U_t(B) = \sum_{k=1}^4 \beta_{1kt} X_{1kt} + \sum_{k=1}^4 \beta_{2kt} X_{2kt} + \sum_{k=1}^4 \beta_{3kt} X_{3kt} + \sum_{k=1}^4 \beta_{4kt} X_{4kt} + \varepsilon_t \quad (5.1)$$

where for Model I:

$U(A), U(B)$  = utility of choosing alternative A and B,

$X_{1t}$  = effect coded price variable for wheat type  $t$  for the first section,

$X_{2kt}$  = ash content level  $k$  in wheat type  $t$  for the first section,

$X_{3kt}$  = falling number level  $k$  in wheat type  $t$  for the first section ,

$X_{4kt}$  = test weight level  $k$  in wheat type  $t$  for the first section,

$\varepsilon_t$  = error term specific to each alternative choice (A and B)

$t$  = wheat type (hard wheat, medium wheat, soft wheat).

where for Model II:

$U(A), U(B)$  = utility of choosing alternative A and B,

$X_{1t}$  = effect coded price variable for flour type  $t$  for the second section,

$X_{2kt}$  = color level  $k$  in flour type  $t$  for the second section,

$X_{3kt}$  = ash content level  $k$  in flour type  $t$  for the second section ,

$X_{4kt}$  = amylograph level  $k$  in flour type  $t$  for the second section,

$\varepsilon_t$  = error term specific to each alternative choice (A and B)

$t$  = noodle flour type (Udon flour, dry noodle flour and instant noodle flour).

where for Model III:

$U(A), U(B)$  = utility of choosing alternative A and B,

$X_{1t}$  = effect coded price variable for wheat type  $t$  for the third section,

$X_{2kt}$  = protein content level  $k$  in wheat type  $t$  for the third section,

$X_{3kt}$  = country of origin  $k$  in wheat type  $t$  for the third section ,

$X_{4kt}$  = dockage level  $k$  in wheat type  $t$  for the third section,

$\varepsilon_t$  = error term specific to each alternative choice (A and B)

$t$  = wheat type (hard wheat, medium wheat, soft wheat).



As noted above, direct interviews were employed to collect the SPM data. The interviewer met 35 mill representatives in South Korea and 23 of these answered the full SPM survey questionnaire. The data on wheat and wheat flour attributes were collected as categorical variables. Dummy variables (-1,+1) are used to effects-code the attribute levels so that the base alternative is exactly equal to the origin. The fourth level of each attribute is omitted during estimation to avoid the singularity and calculated afterward using the effect-coding constraint that all four coefficients on the attribute level must sum to zero (Johnson et al, 1987, p188-90). The standard error of the omitted variable (the fourth level of each factor) is calculated from variance-covariance of the estimated coefficients on other three levels of a factor ( $\beta_1, \beta_2$  and  $\beta_3$ ).

The procedure of effect coding is illustrated in the following equations.

$$V_i = b_0 + b_1 D_1 + b_2 D_2 + b_3 D_3 + b_4 D_4 + e \quad (5.2)$$

where  $V_i$  is indirect utility of choosing alternative  $i$

$b$ 's are coefficients estimated for each factor level (categorical variables)

$D$ 's are dummy variable that translate categorical variables

In order to avoid dummy variable trap, the following restrictions are imposed on the coefficients:

$$b_1 + b_2 + b_3 + b_4 = 0 \quad (5.3)$$

which, when substituted into (5.2), yields

$$V_i = b_0 + b_1 D_1 + b_2 D_2 + b_3 D_3 + (-b_1 - b_2 - b_3) D_4 \quad (5.4)$$

whenever the  $D_4$  level is chosen,  $D_1, D_2$  and  $D_3$  are coded as -1 in the data set.

The non-linear logit procedure of the statistical program Limdep 7.0 (Greene 1995) is used for estimation of the MNL models of Equation (3.4). The respondents who answered the SPM questionnaire also answered the SDS questionnaire. The survey interviews were conducted between January and July in the year of 1999.

### 5.3 RESULTS AND DISCUSSION OF THE SPM ANALYSIS

Empirical results of the estimated models based on the SPM data for Korean millers' choices are given in Tables 5.1 to 5.3. The estimated coefficients denote the relative effects of attributes on the probability of a miller choosing either alternative A or B, based on the specific level of attribute in question. Positive coefficients indicate an increased the probability of product with that factor level being chosen.

#### 5.3.1 Model I: Effects of Price, Ash Content, Falling Number and Test Weight

Model I evaluates the effects of the intrinsic wheat quality factors on millers' choice of semi-hard wheat, medium and soft wheat classes, respectively. Estimated coefficients of these models are reported in Table 5.1. The calculated chi-squared statistic for Model I is 456.36, which is greater than the corresponding critical value at 95% confidence level. This indicates that the specified four attributes in the model are jointly



important in affecting millers' stated preferences in purchasing products. The pseudo  $R^2$  at 0.41 indicates a reasonable measure of goodness-of-fit.

The estimated coefficients on the four factors in Model I had the expected signs and were statistically significant. The estimated coefficient on price indicates that millers prefer lower prices. The reaction to a price increase is strongly negative and the reaction to a price-discount is strongly positive (Table 5.1).

The results in Table 5.1 indicate that South Korean millers reacted negatively to higher levels of ash content. Ash content is an indicator of flour quality since a high ash content indicates significant contamination with aleurone cells and bran during the milling operation (Simmonds, 1989). Hence, this is considered to be one of the most critical factors used by millers in grading wheat and wheat flour (Wheat and Flour, 1999). The estimated coefficients on the ash content factor are consistent with this statement. The levels of ash content that were specified in the questionnaire are the ranges from 1.90% to 1.45% and 1.85% to 1.45%, for semi-hard and medium wheat, respectively (Table 4.3). For the semi-hard and the medium wheat classes, ash content of 1.45 and 1.55, respectively, are preferred. The ash content for soft wheat class ranges from 1.85% to 1.45% in the questionnaire. Millers display a preference for ash content at 1.55 percent for soft wheat (Table 5.1).

Falling number is an index of alpha-amylase activity in wheat flour. As this number increases, the milling characteristics of wheat improve (Wheat and Flour, 1999). The specified levels of falling number classes in the questionnaire range from 250 to 380 for all three wheat (Table 4.3). For all three wheat classes, a falling number below 300 has a negative impact on the probability of millers' purchasing choice (Table 5.1).

With respect to the test weight of wheat, which measures the density of each wheat grain, 77 is found to be the minimum level of acceptance for the semi-hard wheat class, while levels above 79 and 77 are preferred for the medium and soft wheat classes, respectively.

### ***5.3.2 Model II: Effects of Color, Ash Content and Amylograph***

Model II estimated the effects of the specified quality factors of wheat flour on the probability of millers' choices for particular categories of noodle flour. The range of factor levels for each quality attribute are presented in the previous chapter (Tables 4.3 to 4.6). The coefficients on prices had the expected signs and are statistically significant (Table 5.2). The chi-square value from the log likelihood test was estimated to be 273.36, which was greater than the corresponding critical value at 5 % significance level. The pseudo  $R^2$  was 0.26 suggesting Model II had reasonable goodness-of-fit.

Millers grade flour based on three factors: protein content, moisture content and ash content (Wheat and Flour, 1999). Thus, flour ash content is an important indicator of flour. For Udon flour, millers preferred the ash content to be at or below 0.36 percent, and for dry noodle and instant Ramen flour, the preference was for ash to be below 0.43 and 0.41 percent, respectively. The ranges of the flour ash content for three wheat flour categories are defined in the previous chapter (Table 4.5).



Flour color was most frequently mentioned by millers as an important quality attribute in the first set of interviews. For Udon flour, the L value of flour color, which is a measure of whiteness as measured by a colorimeter, is preferred to be 93, while for dry noodle flour, a minimum of 91 is preferred. Millers preferred a narrow range of color values, between 91 and 93, for instant Ramen flour.

Amylograph measures are used to measure the elasticity and texture of wheat flour. Amylograph numbers below 1080 have a negative impact on millers' purchasing decisions for Udon flour. For dry noodle and instant Ramen flour, millers stated a strong negative reaction to amylograph numbers below 730.

### ***5.3.3 Model III: Effects of Protein Content and Dockage Level***

Model III assesses the effects of the second set of major wheat quality factors on miller's decisions to purchase major wheat types. These reflect characteristics that are commonly specified in wheat purchase contracts. The log likelihood ratio statistic indicates that the four attributes examined in this model are jointly important in affecting millers' utility for wheat-flour choice. The Pseudo  $R^2$  value of 0.23 indicates a reasonable fit for this model.

Protein content is viewed to be one of the most critical factors that determine wheat class and wheat quality (Wheat and Flour, 1999). With hard wheat for noodle processing, millers preferred a minimum of 11.5 percent protein, and for medium wheat, a minimum of 10.0 percent protein is preferred (Table 5.3). For the soft wheat category, millers prefer wheat with 9.5 percent protein content. Another important quality factor for wheat is dockage level, which is conventionally specified in the terms of the purchase contract. For all three wheat classes, millers prefer dockage levels to be below 0.4 percent.

### ***5.3.4 Model III: Effects of Country of Origin***

The impact of the country of origin of imported wheat on millers' preference was estimated in the Trade model version (Table 5.3). For both the semi-hard wheat and medium wheat categories, wheat of Australian origin is most preferred by South Korean millers. For the soft wheat category, wheat of U.S. origin is most preferred by the millers. Canadian origin does not have a significant positive effect on Korean millers' preferences for imported wheat. For all three wheat categories, there was a negative impact on millers' wheat purchasing decision for wheat of South Korean origin.

## **5.4 RESULTS AND DISCUSSION OF THE SDS ANALYSIS**

The direct interview method of survey was also employed to collect the SDS data. Both the SPM the SDS questionnaires were presented to the same set of respondents. The interviewer met 35 mill representatives in South Korea and 23 of these answered the full SDS survey questionnaire.

In the semantic differential scale (SDS) approach, millers' attitudes toward each individual product quality characteristics were derived by asking them to give ratings that are based on their reactions to bipolar adjective descriptions of each quality factor (Figure



4.2 and 4.3). In this survey questionnaire, there were three different question sets. The first group of the SDS questionnaire examines the preferred level of quality factors of three wheat classes and the second group of the SDS questionnaire assesses the preferred levels of quality factors of three types of wheat flour. The last group of the SDS questionnaire addresses the relative strength of three major exporting nations in terms of quality of promotional service that they provide to South Korean millers. The scaling questions are intended to probe the direction and intensity of millers' attitude towards the selected factors that are queried.

#### ***5.4.1 SDS Based Assessment of Wheat Quality Characteristics***

The first section of these questions queried responses to six quality factors. Mean values of millers' scaling choices are presented in Table 5.5. The mean score for protein content of hard wheat class was 4.63, indicating that millers' desired level of protein is 12.0 to 12.5 percent for the hard wheat category. Miller's average ratings for protein content for the medium and the soft wheat categories were 4.56 and 4.5, respectively. These related to protein level of 10.5 to 11.0 percent for medium wheat class and 9.5 to 10.0 percent for soft wheat class in actual protein content.

The average rating for ash content that was preferred by Korean millers was 3.55 (1.4 to 1.5 percent)<sup>2</sup> for the semi-hard wheat categories, while the average rating of this factor for the medium wheat category was found to be 3.09 (1.4-1.45 percent). For the soft wheat category, the average rating of ash content was 2.73 (1.35 to 1.40 percent). This indicates that millers prefer lower ash content for softer wheat classes. For moisture content, the average rating was 4.40 (9.5 to 9.7 percent) for the semi-hard wheat, 3.90 (9.3 to 9.5 percent) for the medium wheat and 3.70 (9.0 to 9.4 percent) for the soft wheat. Again millers prefer lower moisture contents for soft wheat class.

The average rating of the falling number was 6.45 (365) for the semi-hard wheat, 6.09 (361) for the medium wheat and 5.36 (353) for the soft wheat. The average rating for test weight was 5.90 (81-82) for the semi-hard wheat, 5.27 (81-82) for the medium wheat, and 5.18 (81-82) for the soft wheat. Korean millers displayed similar preferences for the level of test weight across three wheat classes. In terms of dockage, the preferred level was found to be the same for the semi-hard and the medium wheat classes at 0.4 to 0.45 percent. Korean millers preferred lower dockage level for the soft wheat at 0.35 to 0.40 percent.

The quality factors that are identified in the SPM questionnaire are also used in the SDS questionnaire. Therefore, the results of assessment of wheat quality factors from these two approaches are compared to provide a more comprehensive evaluation of millers' attitudes toward wheat. The preferred levels of protein content for the three wheat types that are calculated from responses to the SDS ratings' choices were consistent with the preferred levels that are estimated from the SPM analysis (Tables 5.2 and Table 5.4). For ash content, the preferred levels suggested by the SDS analysis were found to be slightly higher than those specified and chosen in the SPM analysis. The SPM results indicate

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<sup>2</sup> Numbers in bracket indicate actual level for each factor



that millers' utility increases with higher falling number values. Millers reacted negatively toward a falling number below 300.

The preferred level of falling number for each wheat classes indicated from the SDS evaluation was slightly different from that suggested by the SPM results. Differences in the preferred level of falling number and ash content between the SDS and the SPM analyses may result from the differences in the way each questionnaire is framed. For instance, for each quality factor, four levels are used in the SPM questionnaire, while seven levels are used in the SDS questions, although the same levels of maximum and minimum for each factor are used in SDS analysis. The preferred level of test weight identified from the SPM and the SDS analyses were found to be the same. For dockage level, the millers choices indicated a preference for dockage below 0.4 percent in the SPM analysis, while they specified 0.35- 0.45 percent as the preferred range for dockage in their responses to the SDS survey. Overall, however, the SDS based evaluation of wheat quality generated similar results as seen from the estimation of the SPM model.

#### ***5.4.2 SDS based Assessment of Flour Quality Characteristics***

The second group of the SDS question set involved evaluation of eight separate factors related to the quality of wheat flour (Table 5.5). Preferred levels of color in terms of L value were found to be 91-91.5 for instant Ramen flour, 92-92.5 for Udon flour and 91.5 to 92 for dry noodle flour. These numbers closely match the estimated results from the SPM analysis. The millers preferred amylograph level to be within the range of 800-850 for Ramen flour, 900-950 for Udon flour and 850-900 for dry noodle flour. Compared to these preferences, the results of analysis of the SPM data suggested slightly higher values are preferred for amylograph levels. In terms of ash content, a range of 0.40-0.41 percent was found to be preferred for both Ramen and dry noodle flour from the SDS results, while 0.36-0.37 percent was the preferred range for Udon flour. The SPM estimates of ash content preferences were also at slightly higher values than from the SDS analysis of ash content preferences.

#### ***5.4.3 SDS Based Assessment of Promotional Activities of Exporters***

The third group of the SDS question set contains questions focused on the perceptions of promotional activities and services provided by three major exporting nations (Figure 4.2). Wheat that was of Australian origin was rated to be superior to the other two origins in three aspects: consistency of supply, reliability of suppliers and service. The SPM results showed similar preferences by millers (Table 5.3). The SPM analysis indicated that millers prefer wheat of Australian origin for hard and medium wheat classes, while they prefer wheat of U.S. origin for the soft wheat class (Table 5.3).

### **5.5 THE PREFERRED PRODUCT PROFILES OF THREE WHEAT CLASSES IN SOUTH KOREA**

The estimated coefficients of the SPM models indicate the direction and effect of the relevant independent variable on the probability of millers' purchasing that product. For each independent variable, there are four estimated coefficients since there are four different levels for each factor (Tables 5.1 to 5.4). A positive sign on a parameter estimate suggests the probability of the event increases with the level or presence of this



independent variable (Liao, 1994,p7). Therefore, the variable with the highest estimated value for each set of explanatory variables is presumed to have the largest impact on the probability of millers' purchasing a product. The preferred product profile is derived by selecting those levels of the factors that have the highest positive parameter estimates. The preferred product profiles are compared with the characteristics of the wheat classes that are currently marketed from three major exporters: U.S., Australia and Canada (Tables 5.8 and 5.9). The comparison between the preferred products versus the current market products suggests whether or not each major exporting nation is developing and marketing their wheat according to the quality preferences stated in this study by South Korean millers.

The coefficients on the SPM model indicates that a semi-hard wheat with protein at 12.2 percent and dockage level at 0.2 percent is most preferred by Korean millers. Korean millers also prefer semi-hard wheat with ash content at 1.45 percent, falling number at 380 and test weight at 80 (Table 5.7). For the medium wheat class, they displayed a preference for wheat with protein at 10.7 percent, dockage level at 0.2 percent, ash content at 1.55 percent, falling number at 380 and test weight at 82. For wheat of the soft wheat class Korean millers expressed a preference for protein at 9.5 percent, dockage level at 0.2 percent, ash content at 1.45 percent, falling number at 380 and test weight at 80.

The identified preferred product profiles for three wheat classes are compared with the wheat classes that are currently marketed from the three countries of origin. This comparison reveals how close each exporting nation is to marketing wheat oriented to South Korean millers' preferences. Australia marketed five different wheat classes to South Korea as of 1999 (Table 5.8). This exporting nation developed "Korean noodle wheat", targeted specifically at the Korea Ramen market. This is the 100% Australian noodle wheat category in Table 5.8. The quality profile of this wheat class is similar to the preferred profile of the medium wheat class in Table 5.7. South Korean millers show preference for ash content at or below 1.55%, falling number at 380, test weight at 80, protein content at 10.7% and dockage level at 0.2% or below (Table 5.7). The 100% Australian noodle wheat category has test weight of 81.5, ash content of 1.33%, protein content of 10.2%, dockage of 0.3% and falling number of 395. Thus, Australia has evidently developed a wheat that is particularly suited for millers' preferences in the medium wheat market segment in South Korea.

The medium wheat class that is marketed by the U.S. is HRW (11.5% protein). However, this wheat class has protein content at a level much higher than the level preferred by Korean millers. Falling number of HRW (11.5%) is at a level lower than the level preferred by Korean millers. Canada currently tries to promote CWRS (11.5% protein) to the medium wheat market segment in South Korea.

All three exporting nations compete in the semi-hard wheat market segment. The U.S. markets DNS (14.0% protein), while Canada promotes CWRS (13.5% protein). Australia exports AH for this market segment. The analysis reported here shows Korean millers' preferred profile for the semi-hard wheat class is ash content of 1.45%, falling number of



380, test weight of 80, protein content of 12.2% and dockage level of 0.2%. Australian hard wheat (AH) has protein content which is lower (11.6%) than the preferred level and ash content of a higher level (1.63%) than the preferred level (1.45%). Canadian western red spring wheat (CWRS, 13.5%) has protein content at a higher level (13.3%) than the preferred level (12.2%). CWRS also has a higher level of ash content (1.57%) than the level preferred (1.45%) by Korean millers. The U.S. exports DNS (14.0%) to the Korean semi-hard market segment. This wheat class has protein content (13.5%) that is higher than the preferred level (12.2%). DNS has ash content (1.55%) that is also higher than the preferred level (1.45%). Thus, it appears that there is no distinct market leader in the semi-hard wheat market segment for noodle processing.

The preferred profile by Korean millers for soft wheat includes ash content at 1.55%, falling number at 380, test weight at 80, protein content at 9.5% and dockage level at 0.2% (Table 5.7). The U.S. is competitive in the soft wheat market segment. Canada does not export soft wheat to South Korea market. Canada currently tries to promote CWES to the Korean soft wheat market segment. Australia promotes the Australian soft (AS) wheat class, which has ash content at 1.32%, protein content at 8.7%, dockage at 0.3%, and falling number at 353, while the U.S. exports western white wheat (WW) that has test weight at 57, ash content at 1.45%, protein content at 9.3%, dockage at 0.7% and falling number at 322. WW from the U.S. is closest to the soft wheat profile in terms of protein content preferred by Korean millers.

In terms of the categories of wheat classes that are exported, Australia exports the largest number of wheat categories. From the comparisons of millers' preferences with varieties supplied, overall, Australia is competitive in the medium wheat market segment and the U.S. is competitive in the soft wheat market segments. However, Canada supplies wheat with the lowest level of dockage. Canada has a limited number of categories of wheat classes that are exported to South Korea.

## 5.6 CONCLUSION

The study presents and applies two alternative methods of collecting choice data and assessing millers' attitude to price, country of origin and other significant quality factors of wheat and wheat flour quality for noodle use in South Korea. Overall, the results from both approaches displayed results in identifying similar preferences for wheat and flour quality. The results of the SPM indicate that millers prefer semi-hard and medium wheat of Australian origin, while for the soft wheat class Korean millers expressed a preference for wheat of U.S. origin. Canadian origin does not significantly affect millers' utility. These findings were confirmed by the results of the SDS analysis. The SDS ratings showed that wheat of Australian origin was rated the highest in terms of consistency of supply, reliability and service/assistance. The SPM model generated estimated coefficients on quality factors that had the expected signs and were consistent with the average ratings of each factor derived in the SDS results. Both approaches can be considered to be complementary in deriving South Korean millers' quality preferences for wheat and wheat flour.



The estimated coefficients from the SPM results were used to generate descriptions of preferred product profiles of Korean millers for classes of three wheat. The three wheat profiles are compared with the wheat currently imported by South Korean milling companies. The U.S. is found to be competitive in the soft wheat market segment, while Australia is competitive in the medium wheat segment.



**Table 5.1 Estimated Coefficients of the Multinomial Logit Model I: Korean Market**

|  | Semi-hard Wheat |                              | Medium Wheat |                              | Soft Wheat   |                              |
|--|-----------------|------------------------------|--------------|------------------------------|--------------|------------------------------|
| Factor   | Factor level    | Estimated Coefficient (S.E.) | Factor level | Estimated Coefficient (S.E.) | Factor level | Estimated Coefficient (S.E.) |
| Price  | 10% down        | 1.40*<br>(0.31)              | 10% down     | 1.21*<br>(0.31)              | 10% down     | 1.02*<br>(0.29)              |
|  | 5% down         | 0.12<br>(0.28)               | 5% down      | 0.61*<br>(0.29)              | 5% down      | 0.63*<br>(0.28)              |
|  | No change       | -0.65*<br>(0.27)             | No change    | -1.14*<br>(0.31)             | No change    | -0.43*<br>(0.27)             |
|  | 5% up           | -0.88*<br>(0.28)             | 5% up        | -0.68*<br>(0.28)             | 5% up        | -1.22*<br>(0.29)             |
|  | Ash content     |                              |              |                              |              |                              |
|  | 1.90%           | -1.20*<br>(0.28)             | 1.85%        | -1.76*<br>(0.34)             | 1.85%        | -1.23*<br>(0.28)             |
|  | 1.75%           | 0.27<br>(0.27)               | 1.70%        | 0.16<br>(0.27)               | 1.75%        | -0.42*<br>(0.28)             |
|  | 1.60%           | 0.31*<br>(0.26)              | 1.55%        | 1.02*<br>(0.27)              | 1.55%        | 1.07*<br>(0.27)              |
|  | 1.45%           | 0.63*<br>(0.23)              | 1.45%        | 0.59*<br>(0.25)              | 1.45%        | 0.58*<br>(0.25)              |
| Falling number   | 250             | -3.72*<br>(0.59)             | 250          | -3.31*<br>(0.54)             | 250          | -3.14*<br>(0.51)             |
|  | 300             | 0.79*<br>(0.31)              | 300          | 0.18<br>(0.32)               | 300          | 0.41*<br>(0.29)              |
|  | 337             | 1.37*<br>(0.29)              | 337          | 1.46*<br>(0.30)              | 337          | 1.31*<br>(0.28)              |
|  | 380             | 1.56*<br>(0.30)              | 380          | 1.68*<br>(0.31)              | 380          | 1.42*<br>(0.29)              |
|  | Test weight     |                              |              |                              |              |                              |
|  | 73              | -0.91*<br>(0.31)             | 75           | -0.77*<br>(0.32)             | 75           | -0.47*<br>(0.29)             |
|  | 77              | 0.64<br>(0.25)               | 79           | -0.07*<br>(0.26)             | 77           | -0.18*<br>(0.26)             |
|  | 80              | 0.60*<br>(0.32)              | 82           | 0.78*<br>(0.34)              | 80           | 0.58*<br>(0.30)              |
|  | 84              | 0.31*<br>(0.27)              | 86           | 0.58<br>(0.30)               | 84           | 0.07<br>(0.27)               |
| Log likelihood function                                      |                 |                              | -332.11      |                              |              |                              |
| Log likelihood ratio test ( $\chi^2$ Statistic)              |                 |                              | 456.36*      |                              |              |                              |
| Pseudo $R^2$   |                 |                              | 0.41         |                              |              |                              |
| * indicates statistical significance at 95% confidence level |                 |                              |              |                              |              |                              |
| N (number of respondent) =23                                 |                 |                              |              |                              |              |                              |



**Table 5.2 Estimated Coefficients of the Multinomial Logit Model II: Korean Market**

|  | Udon Flour   |                                 | Dry noodle Flour |                                 | Ramen Flour  |                                 |
|--|--------------|---------------------------------|------------------|---------------------------------|--------------|---------------------------------|
| Factor   | Factor Level | Estimated Coefficient<br>(S.E.) | Factor Level     | Estimated Coefficient<br>(S.E.) | Factor Level | Estimated Coefficient<br>(S.E.) |
| Price  | 10% down     | 0.62*<br>(0.23)                 | 10% down         | 0.63*<br>(0.24)                 | 10% down     | 0.96*<br>(0.24)                 |
|  | 5% down      | 0.49*<br>(0.23)                 | 5% down          | 0.57*<br>(0.25)                 | 5% down      | 0.40*<br>(0.24)                 |
|  | No change    | 0.01<br>(0.22)                  | No change        | -0.06<br>(0.24)                 | No change    | -0.84*<br>(0.25)                |
|  | 5% up        | -1.12*<br>(0.27)                | 5% up            | -1.13*<br>(0.30)                | 5% up        | -0.52*<br>(0.26)                |
|  |              |                                 |                  |                                 |              |                                 |
| Ash content  | 0.38%        | -1.11*<br>(0.27)                | 0.45%            | -1.49*<br>(0.31)                | 0.45%        | -1.38*<br>(0.30)                |
|  | 0.36%        | 0.29*<br>(0.22)                 | 0.43%            | 0.26*<br>(0.24)                 | 0.43%        | -0.39*<br>(0.24)                |
|  | 0.34%        | 0.18<br>(0.23)                  | 0.41%            | 0.41*<br>(0.25)                 | 0.41%        | 0.45*<br>(0.24)                 |
|  | 0.32%        | 0.64*<br>(0.22)                 | 0.38%            | 1.35*<br>(0.26)                 | 0.38%        | 1.31*<br>(0.25)                 |
|  |              |                                 |                  |                                 |              |                                 |
| Color  | 89           | -0.81*<br>(0.25)                | 89               | -0.97*<br>(0.27)                | 89           | -0.46*<br>(0.26)                |
|  | 91           | -0.06<br>(0.21)                 | 91               | 0.07<br>(0.23)                  | 91           | 0.66*<br>(0.23)                 |
|  | 93           | 0.55*<br>(0.23)                 | 93               | 0.83*<br>(0.25)                 | 93           | 0.06<br>(0.23)                  |
|  | 95           | 0.26*<br>(0.22)                 | 95               | 0.07<br>(0.23)                  | 95           | -0.26*<br>(0.24)                |
|  |              |                                 |                  |                                 |              |                                 |
| Amylograph   | 700          | -0.85*<br>(0.25)                | 500              | -1.68*<br>(0.33)                | 500          | -1.61*<br>(0.31)                |
|  | 870          | -0.24*<br>(0.22)                | 730              | 0.44*<br>(0.23)                 | 730          | 0.30*<br>(0.22)                 |
|  | 1040         | 0.52*<br>(0.23)                 | 960              | 0.80*<br>(0.25)                 | 960          | 0.59*<br>(0.25)                 |
|  | 1200         | 0.57*<br>(0.23)                 | 1200             | 0.43*<br>(0.26)                 | 1200         | 0.72*<br>(0.25)                 |
|  |              |                                 |                  |                                 |              |                                 |
| Log likelihood function                                      |              |                                 | -423.61          |                                 |              |                                 |
| Log likelihood ratio test<br>( $\chi^2$ statistic)           |              |                                 | 273.36*          |                                 |              |                                 |
| Pseudo $R^2$   |              |                                 | 0.26             |                                 |              |                                 |
| * indicates statistical significance at 95% confidence level |              |                                 |                  |                                 |              |                                 |
| N (number of respondent) =23                                 |              |                                 |                  |                                 |              |                                 |



**Table 5.3 Estimated Coefficients of the Multinomial Model III: Korean Market**

| Semi-Hard Wheat  |              |                              | Medium Wheat     |                              | Soft Wheat       |                              |
|--|--------------|------------------------------|------------------|------------------------------|------------------|------------------------------|
| Factor   | Factor Level | Estimated Coefficient (S.E.) | Factor Level     | Estimated Coefficient (S.E.) | Factor Level     | Estimated Coefficient (S.E.) |
| Price  | 10% down     | 0.99*<br>(0.23)              | 10% down         | 0.93*<br>(0.22)              | 10% down         | 0.93*<br>(0.21)              |
|  | 5% down      | 0.66*<br>(0.27)              | 5% down          | 0.55*<br>(0.26)              | 5% down          | 0.50*<br>(0.23)              |
|  | No change    | -0.60*<br>(0.25)             | No change        | -0.22*<br>(0.23)             | No change        | -0.34*<br>(0.23)             |
|  | 5% up        | -1.04*<br>(0.27)             | 5% up            | -1.26*<br>(0.27)             | 5% up            | -1.09*<br>(0.26)             |
|  | Protein      | 10.8%                        | -1.04*<br>(0.29) | 9.5%                         | -0.90*<br>(0.27) | 8.5%                         |
|  | 11.5%        | 0.15<br>(0.25)               | 10.2%            | 0.18<br>(0.23)               | 9.0%             | -0.46*<br>(0.24)             |
|  | 12.2%        | 0.48*<br>(0.24)              | 10.7%            | 0.84*<br>(0.24)              | 9.5%             | 0.73*<br>(0.22)              |
|  | 12.8%        | 0.41*<br>(0.23)              | 11.5%            | 0.04<br>(0.22)               | 10.0%            | -0.26*<br>(0.23)             |
| Country of Origin  | The U.S.     | 0.57*<br>(0.25)              | The U.S.         | 0.20*<br>(0.23)              | The U.S.         | 0.41*<br>(0.24)              |
|  | Canada       | -0.13*<br>(0.24)             | Canada           | 0.32<br>(0.23)               | Canada           | 0.02<br>(0.22)               |
|  | Australia    | 1.19*<br>(0.26)              | Australia        | 0.54*<br>(0.23)              | Australia        | 0.25*<br>(0.22)              |
|  | Domestic     | -1.62*<br>(0.33)             | Domestic         | -1.06*<br>(0.28)             | Domestic         | -0.69*<br>(0.25)             |
|  | Dockage      | 0.8                          | -0.88*<br>(0.29) | 0.8                          | -0.64*<br>(0.26) | 0.8                          |
| 0.6  |              | -0.20<br>(0.23)              | 0.6              | -0.03<br>(0.23)              | 0.6              | -0.68*<br>(0.24)             |
| 0.4  |              | -0.18<br>(0.26)              | 0.4              | -0.12<br>(0.25)              | 0.4              | -0.04*<br>(0.24)             |
| 0.2  |              | 1.25*<br>(0.25)              | 0.2              | 0.79*<br>(0.23)              | 0.2              | 0.47*<br>(0.22)              |
| Log likelihood function                                      |              |                              | -426.68          |                              |                  |                              |
| Log likelihood ratio test<br>( $\chi^2$ statistic)           |              |                              | 263.22*          |                              |                  |                              |
| Pseudo $R^2$   |              |                              | 0.23             |                              |                  |                              |
| * indicates statistical significance at 95% confidence level |              |                              |                  |                              |                  |                              |
| N (number of respondent) =23                                 |              |                              |                  |                              |                  |                              |



**Table 5.4 Results of the SDS Analysis of Wheat Quality: Korean Market**

| Attributes /a           | Hard Wheat      |                            | Medium Wheat    |                            | Soft Wheat      |                            |
|-------------------------|-----------------|----------------------------|-----------------|----------------------------|-----------------|----------------------------|
|                         | Attribute Level | Mean Value of Scale (S.D.) | Attribute Level | Mean Value of Scale (S.D.) | Attribute Level | Mean Value of Scale (S.D.) |
| <b>Protein content</b>  | 12.0-12.5%      | 4.63<br>(1.36)             | 10.5-11.0%      | 4.56<br>(1.09)             | 9.5-10.0%       | 4.5<br>(1.10)              |
| <b>Ash content</b>      | 1.4-1.5%        | 3.55<br>(1.44)             | 1.4-1.45%       | 3.09<br>(1.04)             | 1.35-1.40%      | 2.73<br>(1.01)             |
| <b>Moisture content</b> | 9.5-9.7%        | 4.40<br>(2.01)             | 9.3-9.5%        | 3.90<br>(1.79)             | 9.0-9.4%        | 3.70<br>(1.77)             |
| <b>Falling No.</b>      | 365             | 6.45<br>(1.29)             | 361             | 6.09<br>(1.58)             | 353             | 5.36<br>(2.01)             |
| <b>Test weight</b>      | 81-82           | 5.90<br>(1.76)             | 81-82           | 5.27<br>(1.68)             | 81-82           | 5.18<br>(1.66)             |
| <b>Dockage</b>          | 0.40-0.45%      | 2.17<br>(1.99)             | 0.40-0.45%      | 2.17<br>(1.70)             | 0.35-0.40%      | 1.92<br>(1.37)             |

/a Note that scaling range from 1 to 7 with 7 being most preferred.



**Table 5.5 Results of the SDS Analysis of Flour Quality: Korean Market**

| Attributes /a               | Ramen Flour     |                            | Udon Flour      |                            | Dry-noodle Flour |                            |
|-----------------------------|-----------------|----------------------------|-----------------|----------------------------|------------------|----------------------------|
|                             | Attribute Level | Mean Value of Scale (S.D.) | Attribute Level | Mean Value of Scale (S.D.) | Attribute Level  | Mean Value of Scale (S.D.) |
| <b>Color (L value)</b>      | 91-91.5         | 3.18<br>(1.99)             | 92.5-93         | 4.82<br>(2.18)             | 91.5-92          | 3.73<br>(2.00)             |
| <b>Amylograph (AU)</b>      | 800-850         | 4.09<br>(1.51)             | 900-950         | 5.45<br>(1.13)             | 850-900          | 4.55<br>(1.21)             |
| <b>Ash content (%)</b>      | 0.40-0.41%      | 5.29<br>(1.49)             | 0.36-0.37%      | 3.36<br>(1.22)             | 0.40-0.41%       | 5.07<br>(1.27)             |
| <b>Protein content (%)</b>  | 9.30-9.50%      | 5.79<br>(0.80)             | 8.75%           | 4.50<br>(1.22)             | 9.30-9.50%       | 5.79<br>(0.89)             |
| <b>Moisture content (%)</b> | 12.25-12.50%    | 5.85<br>(1.86)             | 12.50-12.75%    | 6.38<br>(1.19)             | 12.20-12.40%     | 5.69<br>(2.17)             |
| <b>Stability (Min)</b>      | 9.75-10.00 min  | 3.91<br>(2.02)             | 9.75-10.00 min  | 3.91<br>(2.11)             | 10.45-10.55 min  | 4.55<br>(2.02)             |
| <b>Elasticity (BU)</b>      | 135-137.5       | 2.4<br>(1.95)              | 140-142         | 3.2<br>(3.03)              | 135-135.5        | 2.0<br>(1.73)              |
| <b>Water absorption (%)</b> | 60              | 4.82<br>(0.60)             | 60              | 5.18<br>(1.40)             | 60               | 5.0<br>(1.09)              |

/a Note that scaling range from 1 to 7 with 7 being most preferred.



**Table 5.6 Results of the SDS Analysis of Service Quality: Korean Market** /a

| Attributes                              | The U.S.           |                            | Canada             |                            | Australia          |                            |
|---|--------------------|----------------------------|--------------------|----------------------------|--------------------|----------------------------|
|   | Attribute Level    | Mean Value of Scale (S.D.) | Attribute Level    | Mean Value of Scale (S.D.) | Attribute Level    | Mean Value of Scale (S.D.) |
| <b>Consistency of supply</b>            | 1: poor<br>7: good | 4.60<br>(1.35)             | 1: poor<br>7: good | 4.93<br>(0.96)             | 1: poor<br>7: good | 5.47<br>(0.99)             |
| <b>Reliability</b>                      | 1: poor<br>7: good | 4.71<br>(1.14)             | 1: poor<br>7: good | 5.00<br>(1.11)             | 1: poor<br>7: good | 5.43<br>(1.16)             |
| <b>Service &amp; Assistance</b>         | 1: poor<br>7: good | 4.67<br>(1.59)             | 1: poor<br>7: good | 5.00<br>(1.25)             | 1: poor<br>7: good | 5.47<br>(1.19)             |
| <b>Variety of Products</b>              | 1: high<br>7: low  | 2.60<br>(1.18)             | 1: high<br>7: low  | 4.33<br>(1.40)             | 1: high<br>7: low  | 3.33<br>(0.90)             |
| <b>Quality of Technical Information</b> | 1: high<br>7: low  | 2.81<br>(1.28)             | 1: high<br>7: low  | 4.00<br>(1.41)             | 1: high<br>7: low  | 2.56<br>(1.36)             |

/a Values are on the seven scales rating without any specific numeric reference. 1 and 7 indicate bipolar adjectives specified for each product profile.



**Table 5.7 Preferred Product Profiles of Wheat and Flour by South Korean Millers**

| A. Preferred Product Profiles for Three Wheat Classes                                  |                 |                  |             |
|--|-----------------|------------------|-------------|
| Factor   | Semi-hard Wheat | Medium Wheat     | Soft Wheat  |
| Ash content  | 1.45%           | 1.55%            | 1.55%       |
| Falling Number   | 380             | 380              | 380         |
| Test Weight  | 80              | 82               | 80          |
| B. Preferred Product Profiles for Three Flour Categories                               |                 |                  |             |
| Factor   | Udon Flour      | Dry noodle Flour | Ramen Flour |
| Ash content  | 0.32%           | 0.38%            | 0.38%       |
| Color  | 93              | 93               | 91          |
| Amylograph   | 1200            | 960              | 1200        |
| C. Preferred Product Profiles for Three Wheat Classes relating to Trade Contract Terms |                 |                  |             |
| Factor   | Semi-hard Wheat | Medium Wheat     | Soft Wheat  |
| Protein content  | 12.2%           | 10.7%            | 9.5%        |
| Country of Origin  | Australia       | Australia        | The U.S.    |
| Dockage Level  | 0.2%            | 0.2%             | 0.2%        |



**Table 5.8 Quality Report on Australian Wheat for Korean Market (1998/99)**

| Attribute /a       | ASW Blend /b<br>(Western<br>Australia) | 100%<br>Australian<br>Noodle Wheat | AS /c  | AH /d  | APH /e |
|--------------------|--|------------------------------------|--------|--------|--------|
| Test weight        | 82.5                                   | 81.5                               | 79.5   | 82.0   | 80.5   |
| Ash content        | 1.35 %                                 | 1.33 %                             | 1.32 % | 1.41%  | 1.63%  |
| Protein<br>content | 10.4 %                                 | 10.2%                              | 8.7 %  | 11.7 % | 13.2%  |
| Dockage            | 0.2 %                                  | 0.32 %                             | 0.3 %  | 0.36 % | 0.36 % |
| Falling<br>number  | 452                                    | 395                                | 353    | 356    | 490    |

/a Source: Australian Wheat Board (AWB) Crop Report to South Korea, 1998/99

/b Australian Standard White (ASW) Blend

/c Australian Soft (AS)

/d Australian Hard (AH)

/e Australian Prime Hard (APH)

**Table 5.9 Quality Report on U.S. and Canadian Wheat (1997)**

| Attribute /a       | DNS (14.0%) /b | HRW (11.5%) /c | WW /d | CWRS<br>(13.5%) /e |
|--------------------|----------------|----------------|-------|--------------------|
| Test weight        | 96             | 87             | 57    | 92                 |
| Ash content        | 1.55 %         | 1.52 %         | 1.45% | 1.60 %             |
| Protein<br>content | 13.5 %         | 11.3 %         | 9.3 % | 13.4 %             |
| Dockage            | 0.8 %          | 0.6 %          | 0.7 % | 0.4 %              |
| Falling<br>number  | 361            | 335            | 322   | 327                |

/a Wheat classes from the U.S. and Canada that are marketed in South Korea;

Source: The Quality Report six year average (1993-98), by Cheil Chedang Inc. Co. 1999

/b Dark Northern Spring (DNS)

/c Hard Red Winter (HRW)

/d Western White (WW)

/e Canadian Western Red Spring (CWRS)



## **6. EMPIRICAL RESULTS FOR THE JAPANESE MARKET**

### **6.1 INTRODUCTION**

This chapter reports on the results of the SPM analysis that was applied to the Japanese market. Collection of the survey data on the SDS questionnaire was attempted, however, Japanese millers frequently reported difficulties in answering these questions. More than fifty percent of the respondents were unable to answer the complete set of SDS questions. The respondents in the Japanese milling industry were more interested in discussing the current status of the Japanese milling industry than in responding to the set of SDS questions.

Failure in collection of the SDS data in Japan even after pre-testing may be due to the nature of the wheat import system of that nation. Millers in South Korea purchase imported wheat in an open market setting. Consequently, they are able to express their preferences more explicitly for each specific quality factor and level. One of the important implications of privatization of importing system is a tendency for greater specificity in purchase contracts (Bruce and Wilson, 2000). Private traders have a greater incentive to evaluate the value of higher quality and may be more willing to pay premiums if greater quality enhances their profits. This could provide the explanation of why Korean millers could evaluate the attribute of each quality factor separately. In contrast, millers in Japan have limited choices of wheat classes currently since the Japan Food Agency (JFA) governs the quantity and quality of the wheat imported to Japan. Hence, they may be able to make choices of wheat more easily when alternate comprehensive product profiles are presented to them. This setting can be generated in the SPM questionnaire. However, millers may not be used to identifying separate ratings for particular quality factors and their levels, which is the focus of the SDS questions. Since more than fifty percent of the Japanese miller respondents were unable to answer the questions on the SDS questionnaires, this chapter only reports the results of the analysis of SPM data generated from the survey of Japanese market. The multinomial logit model (MNL) which was applied to the Korean SPM data set was the model postulated to analyze the Japanese SPM data set. Explanation of the estimation procedure is omitted in this chapter since this is identical to the analysis conducted on the Korean data.

### **6.2 MNL MODEL SPECIFICATION**

The SPM survey data provided information on seven different quality factors for three wheat classes. Each factor was specified with four levels. The survey also provided information on millers choices relating to four different factors for four wheat flour products, which were specified with four levels. For this analysis, three separate sets of models were developed and estimated; Models I and III were estimated with data on three wheat classes that are obtained from the SPM survey. Model II was estimated on the SPM data sets for four categories of noodle flour.

The choice and nature of the factors and factor levels used in the MNL model for the Japanese case were explained previously in Chapter 4 (Tables 4.3 to 4.6). The general description of Models I, II and III are found in Chapter 5 (Section 5.3). Japanese millers'



preferences for flour (Model II) included one additional product category than was considered by Korean millers (Tables 4.1 and 4.2). There are four product categories in the wheat flour section in the SPM questionnaire for Japanese millers : Udon-flour, dry noodle-flour, fresh Ramen-flour and instant Ramen-flour. The SPM questionnaire directed at Japanese millers consists of ten versions of the question sets. Model I analyzes the effects of wheat quality factors on Japanese millers' choice behavior. Model II focuses on the effects of noodle flour quality factors on the choices of flour products by Japanese millers. Model III assesses the effects of the second set of wheat quality factors on Japanese millers' wheat choice behavior.

The Japanese respondents were mostly senior-level sales and quality managers, with 10 or more years of experience in the business of milling technology. The milling companies that were surveyed are the large and medium size companies that are amongst the 25 largest milling companies in Japan. These companies represent 85 percent of the sales of the entire milling industry in Japan (Interview, 1999). Direct interviews were employed to collect the survey data in Japan. The interviewer met 57 mill representatives in Japan and 41 of these responded to the full SPM survey questionnaire. The survey interviews were administered between January and July in the year of 1999.

## **6.3 RESULTS AND DISCUSSION OF THE SPM ANALYSIS**

### ***6.3.1 Model Diagnostics***

The calculated chi squared statistic from each of the log likelihood tests for each individual model indicated that in each model the specified attributes were jointly important in affecting buyers' preferences in purchasing wheat or flour. The pseudo R squared values were 0.29, 0.27 and 0.23 for Model I, II and III, respectively, indicating a reasonable fit for each model. The coefficient estimates were statistically significant in all three models (Tables 6.1 to 6.3).

### ***6.3.2 Model I: Effects of Ash Content, Falling Number and Test Weight***

Model I estimates the effects of the wheat quality factors on millers' purchasing decisions. In this model, millers' choice behavior was assumed to be influenced by price and the quality attributes of ash content, falling number and test weight. Estimated coefficients of Model I are reported in Table 6.1. The estimated coefficients on the price variable have the expected negative sign and are statistically significant, indicating that buyers prefer lower prices. For hard wheat, ash content at or below 1.60 percent was preferred. For the semi-hard and medium wheat classes, ash content at 1.45 and 1.55 percent or below was preferred, respectively.

Falling number, an indicator of the texture quality of final noodle products, is viewed as an important factor in determining wheat quality by Japanese millers. For hard wheat and medium wheat classes, Japanese millers specified a preference for falling number of 380. For semi-hard wheat, they preferred the falling number at 337. Test weight measures the density of wheat kernels. For this factor, 80 was found to be the minimum acceptance level by Japanese millers for all three wheat classes.



### **6.3.3 Model II: Effects of Color, Ash Content and Amylograph**

Model II estimated the effects of price, ash content, color and amylograph on Japanese millers' choices of noodle flour. The estimated coefficients for the price variable had the expected signs in all four noodle flour categories (Table 6.2). The color of the flour also is important since this influences the color of the noodles. For Udon and dry noodle flour, the L value of the flour color, an index of whiteness of flour, is preferred to be 93, and for fresh Ramen flour, 90 is the preferred L value. Millers preferred L value of 92 for instant Ramen flour. The preferred ash content in wheat flour (Table 6.2) was lower than the preferred ash content for wheat (Table 6.1). For dry noodle flour, Japanese millers strongly rejected ash content above 0.48 percent. The millers also rejected ash content above 0.50 percent for instant Ramen flour. Japanese millers preferred ash content of 0.35 percent for Udon and fresh Ramen flour, respectively. Amylograph numbers measure the elasticity and texture of wheat flour. Amylograph numbers below 400 have a negative impact on Japanese millers' choice decisions for all four types of noodle flour.

### **6.3.4 Model III: Effects of Protein Content and Dockage Level**

Model III assessed the impacts of wheat quality factors that are cited in sale contracts, on Japanese millers' choices (Table 6.3). In this model, price, protein content, country of origin and dockage level are the specified choice factors. Protein content is used to categorize the class or type of wheat and flour and this factor is conventionally specified in the terms of trade, ie in the sale contract. For hard wheat used in noodle processing, millers preferred 12.8 percent protein, and for semi-hard wheat, a minimum of 10.7 percent protein is preferred. For the medium wheat class, Japanese millers prefer a minimum of 9.5 percent for protein. Dockage level is another quality factor, specified as a standard term in the terms of trading (sales) contracts. Dockage level measures the content of foreign materials in wheat grains, reflecting purity of the grain in the shipment. Hence, this attribute is believed to influence wheat prices. For all three wheat classes, millers prefer dockage levels to be below 0.4 percent.

### **6.3.5 Model IIII: Effects of Country of Origin**

The effect of the country of origin on millers' choices of imported wheat was estimated in Model III and these estimates are presented in Table 6.3. For semi-hard wheat and medium wheat classes, wheat of Australian origin is most preferred by Japanese millers. For the hard wheat category, wheat of U.S. origin is most preferred by Japanese millers. Domestic origin has a significant positive effect on Japanese millers' preferences for the medium wheat category, while wheat that is of Canadian origin has a significant positive effect on the millers' choice decisions for hard wheat.

## **6.4 THE PREFERRED PRODUCT PROFILES FOR THREE WHEAT CLASSES IN JAPAN**

The estimated coefficients of the SPM models in Japanese market provide information on specific levels of each factor which are preferred by millers in Japan. A positive coefficient estimate on a particular factor level indicates a positive impact of this factor level on the probability of millers' purchase choices. Therefore, the factor levels



that have the highest positive parameter estimates are considered to be most preferred by millers among the four specified levels. Combining the preferred level of each factor generates a preferred product profile for wheat and wheat flour. The preferred product profiles for each wheat class are presented in Table 6.4. Following the procedure reported in Chapter 5 for Korean millers, the preferred product profiles identified in the Japanese market are compared with the wheat classes that are currently marketed from three major exporters: the U.S., Australia and Canada (Tables 6.5 and 6.6). Comparison of the preferred products with currently marketed products indicates how closely each exporting nation caters to Japanese millers' preferences in terms of the specified wheat quality factors. This suggests whether or not each exporting nation is following an effective marketing strategy.

The preferred profiles for three wheat classes identified from the estimation of the SPM model can be compared to wheat that is currently marketed by the U.S., Australia and Canada (Tables 6.5 and 6.6). The preferred profile of the hard wheat class suggests ash content at 1.60%, falling number at 380, test weight at 84, protein content at 14.0% and dockage level at 0.2% (Table 6.4). The U.S. currently markets dark northern spring (DNS) that is most closely related to this description. This wheat class is specified to have test weight of 80, ash content of 1.60%, protein content at 14.0%, dockage level at 0.5% and falling number of 406. Thus, DNS matches the protein content and the ash content preference expressed by Japanese millers for the hard wheat class, as identified in this study. Since protein and the ash content are two of the most critical factors determining the quality of wheat, it would seem that as a product, DNS is competitive in the hard wheat market segment in Japan.

Canada supplies Canadian western red spring (CWRS, 13.5%) to the Japanese market, however, the quality specifications of this wheat class do not clearly match with the Japanese millers' stated preferences for hard wheat and semi-hard wheat class used in processing noodle flour. The protein content of CWRS is 13.3% which is lower than millers prefer for hard wheat, and the ash content of CWRS, which is 1.57%, is higher than is stated to be preferred for semi-hard wheat category.

Australia exports Australian prime hard (APH) at two different protein levels: 14.7% and 13.7%. The APH with 14.7% has a higher level of protein than stated for the preferred level (14.0%) and is higher in falling number (713) than stated for the preferred level (380). The second category of APH with lower protein content (13.7%) is also higher in falling number (512) than the preferred level although its protein content is closer to the preferred level.

In summary, Canada and Australia both have hard wheat classes that are marketed to Japan, but the wheat from these two nations does not precisely meet Japanese millers' preferences for the hard wheat category that is used in production of noodle flour. It is likely that CWRS and APH are mostly used in processing bread flour in Japan. If Canada and Australia intend to expand their market shares in the noodle wheat market segment, particularly in the hard wheat category, they need to increase emphasis on niche marketing of hard wheat with specifications that match Japanese millers' preferences.



Product improvement of hard wheat specified for noodle flour uses in Japan by Australia and Canada would involve focusing on the levels of ash content and protein content.

The preferred profile for the semi-hard wheat category shows that ash content at 1.45%, falling number at 337, test weight at 80, protein content at 12.0% and dockage level at 0.2% are preferred (Table 6.4). Neither Australia nor Canada exports a wheat class that has protein content of 12.0%. The U.S. supplies two types of HRW that have different levels of protein content. One is HRW with protein content of 12.9% and the second type is HRW with protein content of 11.6%. However, even HRW from the U.S. requires improvement in the level of ash content since neither of these HRW categories has an ash content that closely matches the preferred level of ash content by Japanese millers. For instance, HRW with protein content of 12.9% has ash content of 1.57% and HRW with protein content of 11.6% has ash content at 1.54%. Thus both categories of HRW have higher levels of ash content than is stated to be preferred (1.45%) by Japanese millers.

In the medium wheat category, Australia supplies an Australian standard white (ASW) blend from western Australia that has test weight of 81, ash content of 1.35%, protein content of 10.4%, dockage level of 0.3% and falling number of 425. The preferred profile of medium wheat stated by Japanese millers has ash content of 1.55%, falling number of 380, test weight of 80, protein content of 10.7% and dockage level of 0.2%. Thus, the quality characteristics of ASW are close to the preferred profile of the medium wheat category stated by the Japanese millers. ASW has the average of ash content at a much lower level (1.35%) than the preferred level (1.55%). The ASW also has protein content (10.4%) that approximately matches the preferred level (10.7%). Thus, in terms of product characteristics, Australia is competitive in the medium wheat market segment and its marketing strategy for medium wheat appears to be highly effective for Japan.

## 6.5 CONCLUSION

This chapter reported on the analysis of stated preference method (SPM) data to evaluate millers' attitudes to price, country of origin and other significant quality factors of wheat and wheat flour for noodle manufacturing in Japan. The results show that Japanese millers are very sensitive to price changes for all classes of wheat and wheat flour. A distinct preference for wheat of particular origins is stated by millers for each wheat class. Millers prefer U.S. and Canadian origins for hard wheat. They express a preference for Australian origin for the semi-hard and medium wheat classes. Ash content, falling number, test weight, protein content and dockage level were found to be of importance in Japanese millers' choices of wheat and flour for noodle making. Millers identified color, ash content and amylograph values as important determinants of the quality of noodle flour. The SPM analysis was the basis for inferring the explicit levels of each quality factor of wheat and flour that is preferred by Japanese millers.

The estimated coefficients from the SPM analysis are used to identify profiles of wheat and flour that are preferred by Japanese millers for each of three wheat classes that are used in noodle flour processing. The preferred profiles for each wheat class are then compared with wheat classes marketed by Australia, Canada and the U.S. Australia is evidently supplying a product that matches preferences in the medium wheat market



segment, while the U.S. is competitive in catering to preference for the hard and the semi-hard wheat market segment. Canada currently does not supply wheats which can be used in noodle flour processing that match the preferred quality specifications stated by Japanese millers.



**Table 6.1 Estimated Coefficients of the Multinomial Logit Model I: Japanese Market**

| Factor   | Hard Wheat   |                                | Semi-hard Wheat |                                | Medium Wheat |                                |
|--|--------------|--------------------------------|-----------------|--------------------------------|--------------|--------------------------------|
|  | Factor Level | Estimated Coefficient<br>(S.E) | Factor Level    | Estimated Coefficient<br>(S.E) | Factor Level | Estimated Coefficient<br>(S.E) |
| Price  | 2% down      | 0.65*<br>(0.19)                | 2% down         | 0.83*<br>(0.18)                | 2% down      | 0.70*<br>(0.19)                |
|  | 1% down      | 0.16<br>(0.18)                 | 1% down         | 0.06<br>(0.18)                 | 1% down      | 0.20*<br>(0.19)                |
|  | No change    | -0.07<br>(0.19)                | No change       | -0.31*<br>(0.19)               | No change    | -0.17<br>(0.19)                |
|  | 1% up        | -0.74*<br>(0.21)               | 1% up           | -0.57*<br>(0.21)               | 1% up        | -0.72*<br>(0.20)               |
|  |              |                                |                 |                                |              |                                |
| Ash content  | 1.90%        | -1.02*<br>(0.21)               | 1.85%           | -1.16*<br>(0.20)               | 1.85%        | -1.40*<br>(0.22)               |
|  | 1.75%        | -0.39*<br>(0.18)               | 1.70%           | -0.52*<br>(0.19)               | 1.70%        | -0.78*<br>(0.19)               |
|  | 1.60%        | 0.84*<br>(0.18)                | 1.55%           | 0.54*<br>(0.17)                | 1.55%        | 1.12*<br>(0.17)                |
|  | 1.45%        | 0.75*<br>(0.18)                | 1.45%           | 1.13*<br>(0.18)                | 1.45%        | 1.07*<br>(0.17)                |
|  |              |                                |                 |                                |              |                                |
| Falling number                                     | 250          | -0.95*<br>(0.19)               | 250             | -1.46*<br>(0.23)               | 250          | -0.96*<br>(0.20)               |
|  | 300          | 0.57<br>(0.19)                 | 300             | 0.23*<br>(0.19)                | 300          | 0.07<br>(0.20)                 |
|  | 337          | 0.42*<br>(0.18)                | 337             | 0.67*<br>(0.18)                | 337          | 0.26*<br>(0.18)                |
|  | 380          | 0.48*<br>(0.17)                | 380             | 0.56*<br>(0.18)                | 380          | 0.63*<br>(0.18)                |
|  |              |                                |                 |                                |              |                                |
| Test weight  | 73           | -1.63*<br>(0.24)               | 75              | -0.95*<br>(0.22)               | 75           | -0.60*<br>(0.21)               |
|  | 77           | -0.39<br>(0.18)                | 77              | -0.04<br>(0.18)                | 77           | -0.20*<br>(0.18)               |
|  | 80           | 0.68*<br>(0.17)                | 80              | 0.53*<br>(0.19)                | 80           | 0.42*<br>(0.18)                |
|  | 84           | 1.00*<br>(0.18)                | 84              | 0.46*<br>(0.18)                | 84           | 0.38*<br>(0.18)                |
|  |              |                                |                 |                                |              |                                |
| Log likelihood function                            |              |                                | -726.89         |                                |              |                                |
| Log likelihood ratio test<br>( $\chi^2$ statistic) |              |                                | 589.66*         |                                |              |                                |
| Pseudo $R^2$                                       |              |                                | 0.29            |                                |              |                                |
| N ( number of respondent)=41                       |              |                                |                 |                                |              |                                |



Table 6.2 Estimated Coefficients of the Multinomial Logit Model II: Japanese Market

|   | Udon Flour   |                              | Dry noodle Flour |                              | Fresh Chinese-noodle Flour |                              | Ramen Flour  |                              |
|---|--------------|------------------------------|------------------|------------------------------|----------------------------|------------------------------|--------------|------------------------------|
| Factor  | Factor Level | Estimated Coefficient (S.E.) | Factor Level     | Estimated Coefficient (S.E.) | Factor Level               | Estimated Coefficient (S.E.) | Factor Level | Estimated Coefficient (S.E.) |
| Price   | 2% down      | 0.58* (0.19)                 | 2% down          | 0.10 (0.18)                  | 2% down                    | 0.30* (0.18)                 | 2% down      | 1.03* (0.18)                 |
|   | 1% down      | 0.51* (0.17)                 | 1% down          | 0.58* (0.17)                 | 1% down                    | 0.38* (0.17)                 | 1% down      | 0.43* (0.17)                 |
|   | No change    | -0.29* (0.19)                | No change        | 0.06 (0.18)                  | No change                  | -0.07 (0.18)                 | No change    | -0.16 (0.18)                 |
|   | 1% up        | -0.80* (0.21)                | 1% up            | -0.73* (0.20)                | 1% up                      | -0.60* (0.19)                | 1% up        | -1.30* (0.22)                |
|   |              |                              |                  |                              |                            |                              |              |                              |
|   |              |                              |                  |                              |                            |                              |              |                              |
| Ash content                                     | 0.50%        | -1.83* (0.25)                | 0.55%            | -1.17* (0.20)                | 0.50%                      | -1.50* (0.22)                | 0.50%        | -1.58* (0.23)                |
|   | 0.42%        | -0.14 (0.19)                 | 0.48%            | -0.58* (0.19)                | 0.48%                      | -0.17 (0.18)                 | 0.42%        | 0.22* (0.18)                 |
|   | 0.38%        | 0.68* (0.18)                 | 0.42%            | 0.29* (0.16)                 | 0.42%                      | 0.32* (0.16)                 | 0.38%        | 0.42* (0.17)                 |
|   | 0.35%        | 1.29* (0.19)                 | 0.35%            | 1.46* (0.18)                 | 0.35%                      | 1.35* (0.18)                 | 0.35%        | 0.94* (0.18)                 |
|   |              |                              |                  |                              |                            |                              |              |                              |
| Color   | 89           | -0.55* (0.21)                | 89               | -0.34* (0.20)                | 89                         | -0.16* (0.19)                | 90           | -0.24* (0.18)                |
|   | 91           | 0.21* (0.19)                 | 90               | 0.09 (0.18)                  | 90                         | 0.28* (0.18)                 | 91           | 0.08 (0.18)                  |
|   | 93           | 0.35* (0.18)                 | 92               | 0.12 (0.18)                  | 92                         | -0.09 (0.18)                 | 92           | 0.09 (0.17)                  |
|   | 95           | -0.01 (0.18)                 | 93               | 0.13 (0.17)                  | 93                         | -0.03 (0.17)                 | 94           | 0.07 (0.17)                  |
|   |              |                              |                  |                              |                            |                              |              |                              |
| Amylograph                                      | 250          | -1.69* (0.24)                | 250              | -0.89* (0.20)                | 250                        | -1.02* (0.20)                | 250          | -1.17* (0.21)                |
|   | 300          | -0.14 (0.18)                 | 300              | -0.31* (0.17)                | 300                        | -0.28 (0.17)                 | 300          | -0.17 (0.18)                 |
|   | 400          | 0.50* (0.19)                 | 400              | 0.19* (0.17)                 | 400                        | 0.18* (0.18)                 | 400          | 0.24* (0.18)                 |
|   | 500          | 1.32* (0.21)                 | 500              | 1.01* (0.18)                 | 500                        | 1.12* (0.19)                 | 500          | 0.11* (0.19)                 |
|   |              |                              |                  |                              |                            |                              |              |                              |
| Log likelihood function                         |              | -1001.13                     |                  |                              |                            |                              |              |                              |
| Log likelihood ratio test ( $\chi^2$ statistic) |              | 731.08*                      |                  |                              |                            |                              |              |                              |
| Pseudo $R^2$                                    |              | 0.27                         |                  |                              |                            |                              |              |                              |
| N ( number of respondent)=41                    |              |                              |                  |                              |                            |                              |              |                              |



**Table 6.3 Estimated Coefficients of the Multinomial Logit Model III: Japanese Market**

| Factor   | Hard Wheat   |                                 | Semi-hard Wheat |                                 | Medium Wheat |                                 |
|--|--------------|---------------------------------|-----------------|---------------------------------|--------------|---------------------------------|
|  | Factor Level | Estimated Coefficient<br>(S.E.) | Factor Level    | Estimated Coefficient<br>(S.E.) | Factor Level | Estimated Coefficient<br>(S.E.) |
| <b>Price</b>                                       | 2% down      | 0.76*<br>(0.17)                 | 2% down         | 0.98*<br>(0.17)                 | 2% down      | 1.14*<br>(0.17)                 |
|  | 1% down      | 0.61*<br>(0.17)                 | 1% down         | 0.57*<br>(0.17)                 | 1% down      | 0.67*<br>(0.16)                 |
|  | No change    | -0.21<br>(0.17)                 | No change       | -0.18*<br>(0.17)                | No change    | -0.36*<br>(0.18)                |
|  | 1% up        | -1.17*<br>(0.21)                | 1% up           | -1.37*<br>(0.21)                | 1% up        | -1.46*<br>(0.22)                |
|  |              |                                 |                 |                                 |              |                                 |
| <b>Protein</b>                                     | 12.0%        | -0.90*<br>(0.20)                | 10.2%           | -0.78*<br>(0.20)                | 9.5%         | -0.30*<br>(0.18)                |
|  | 12.7%        | -0.37*<br>(0.18)                | 11.0%           | -0.46*<br>(0.18)                | 10.2%        | -0.06<br>(0.18)                 |
|  | 13.5%        | 0.59*<br>(0.17)                 | 12.0%           | 0.73*<br>(0.17)                 | 10.7%        | 0.24*<br>(0.17)                 |
|  | 14.0%        | 0.69*<br>(0.16)                 | 12.8%           | 0.51*<br>(0.16)                 | 11.5%        | 0.13<br>(0.16)                  |
|  |              |                                 |                 |                                 |              |                                 |
| <b>Country of Origin</b>                           | The U.S.     | 0.36*<br>(0.16)                 | The U.S.        | 0.12<br>(0.17)                  | The U.S.     | -0.12<br>(0.17)                 |
|  | Canada       | 0.21*<br>(0.17)                 | Canada          | 0.04<br>(0.18)                  | Canada       | -0.47*<br>(0.17)                |
|  | Australia    | -0.12<br>(0.17)                 | Australia       | 0.17*<br>(0.17)                 | Australia    | 0.37*<br>(0.17)                 |
|  | Domestic     | -0.46*<br>(0.18)                | Domestic        | -0.32*<br>(0.18)                | Domestic     | 0.22*<br>(0.18)                 |
|  |              |                                 |                 |                                 |              |                                 |
| <b>Dockage</b>                                     | 0.8          | -0.80*<br>(0.20)                | 0.8             | -0.83*<br>(0.20)                | 0.8          | -1.14*<br>(0.22)                |
|  | 0.6          | -0.27*<br>(0.17)                | 0.6             | -0.41*<br>(0.17)                | 0.6          | -0.32*<br>(0.17)                |
|  | 0.4          | 0.28*<br>(0.17)                 | 0.4             | 0.30*<br>(0.17)                 | 0.4          | 0.41*<br>(0.17)                 |
|  | 0.2          | 0.81*<br>(0.16)                 | 0.2             | 0.94*<br>(0.17)                 | 0.2          | 1.06*<br>(0.18)                 |
|  |              |                                 |                 |                                 |              |                                 |
| Log likelihood function                            |              |                                 | -803.55         |                                 |              |                                 |
| Log likelihood ratio test<br>( $\chi^2$ statistic) |              |                                 | 475.86*         |                                 |              |                                 |
| Pseudo $R^2$                                       |              |                                 | 0.23            |                                 |              |                                 |
| N ( number of respondent)=41                       |              |                                 |                 |                                 |              |                                 |



**Table 6.4 Preferred Product Profiles of Wheat and Flour by Japanese Millers**

| A. Preferred Product Profile for Three <b>Wheat</b> Classes                                  |            |                  |                            |             |
|--|------------|------------------|----------------------------|-------------|
| Factor   | Hard Wheat | Semi-Hard Wheat  | Medium Wheat               |             |
| Ash content  | 1.60%      | 1.45%            | 1.55%                      |             |
| Falling Number   | 380        | 337              | 380                        |             |
| Test Weight  | 84         | 80               | 80                         |             |
| B. Preferred Product Profile for Four <b>Flour</b> Categories                                |            |                  |                            |             |
| Factor   | Udon Flour | Dry noodle Flour | Fresh Chinese-noodle Flour | Ramen Flour |
| Ash content  | 0.35%      | 0.35%            | 0.35%                      | 0.35%       |
| Color  | 93         | 93               | 90                         | 92          |
| Amylograph   | 500        | 500              | 500                        | 400         |
| C. Preferred Product Profile for Three <b>Wheat</b> Classes relating to Trade Contract Terms |            |                  |                            |             |
| Factor   | Hard Wheat | Semi-Hard Wheat  | Medium Wheat               |             |
| Protein content  | 14.0%      | 12.0%            | 10.7%                      |             |
| Country of Origin  | The U.S.   | Australia        | Australia                  |             |
| Dockage Level  | 0.2%       | 0.2%             | 0.2%                       |             |



**Table 6.5 Quality Report on U.S. and Canadian Wheat (1997)**

| Attribute /a    | DNS (14.0%) /b | HRW (13.0%) /c | HRW (11.5%) | WW /d   | CWRS (13.5) /e |
|-----------------|----------------|----------------|-------------|---------|----------------|
| Test weight     | 80             | 80             | 80.5        | 80      | 80.            |
| Ash content     | 1.60 %         | 1.57 %         | 1.54 %      | 1.43%   | 1.57%          |
| Protein content | 14.0 %         | 12.9 %         | 11.6 %      | 9.5-10% | 13.3 %         |
| Dockage         | 0.5 %          | 0.5 %          | 0.3 %       | 0.5 %   | 0.2 %          |
| Falling number  | 406            | 460            | 431         | 379     | 406            |

/a Source: Japan Food Agency (JFA), The Quality Survey, 1997

/b Dark Northern Spring (DNS)

/c Hard Red Winter (HRW)

/d Western White (WW)

/e Canadian Western Red Spring (CWRS)

**Table 6.6 Quality Report of Australian Wheat for Japanese Market (1997)**

| Attribute /a    | ASW Blend (Western Australia) | APH (13.0%) | APH (14.0%) | G.P. /b |
|-----------------|-------------------------------|-------------|-------------|---------|
| Test weight     | 81                            | 82.5        | 83          | 78      |
| Ash content     | 1.35 %                        | 1.33 %      | 1.32 %      | 1.63%   |
| Protein content | 10.4 %                        | 13.7%       | 14.7%       | 10.4 %  |
| Dockage         | 0.3 %                         | 0.2 %       | 0.3 %       | 0.5 %   |
| Falling number  | 425                           | 512         | 713         | N/A     |

/a Wheat classes that are particularly marketed to Japan; Source: JFA, The Quality Survey, 1997

/b General Purpose (GP).



## 7. COMPARISON OF KOREAN AND JAPANESE MILLERS' CHOICES

### 7.1 INTRODUCTION

Development of the empirical model is reported in Chapter 4. The empirical model that was developed in Chapter 4 generated results that are outlined in Chapters 5 and 6. The results of the SPM analysis in Chapters 5 and 6 were used to derive preferred product profiles of wheats that are used in milling noodle flour. The preferred profiles of three wheat classes in Japan and South Korea were then compared with the wheat currently marketed in each country by three major exporting nations. This comparison gives insight on the extent to which wheat exporters currently cater to preferences of Korean and Japanese millers. One further component of this study is based on comparison of the preferences of Japanese and Korean millers for wheat and flour quality factors. The first part of this chapter provides a summary of the preferred product profiles for wheat and wheat flour for both Japanese and Korean markets. The second section describes how the estimated coefficients of the multinomial logit (MNL) model, which are used in determining the preferred product profiles can be translated into marginal values. Marginal analysis on the factor levels of wheat and flour factors is performed in order to assess the marginal influence on millers' choices of a change in one factor level, holding all else constant. This allows direct comparisons of the preferences of Japanese and South Korean millers for wheat and flour products. The second section also includes discussions of results of the marginal analysis. The last section of this chapter presents discussion of marketing implications based on results and conclusions drawn from Chapters 5,6 and 7.

### 7.2 MARGINAL EFFECTS OF CHANGING PARTICULAR WHEAT QUALITY FACTORS

The specification of the multinomial (MNL) models is different for the Japanese and South Korean markets since different factors and factor-levels are used in each case. Therefore, direct comparison of the parameter estimates of the MNL models in these two markets is not feasible. An alternative approach to interpret the results of the MNL model is to examine the marginal effect of the estimated coefficients, which can allow direct comparison of the Japanese and the Korean models. As such the comparative discussion of the results focuses on the marginal analysis given below.

As noted in the previous chapters, the MNL model can be specified as:

$$\pi_n(i) = \frac{\exp(\beta'X_{in})}{1 + \sum_j \exp(\beta'X_{jn})} \quad (7.1)$$

where :

$\pi_n(i)$  = Respondent n's choice probability of alternative  $i$ ,

$X_{in}$  and  $X_{jn}$  = vectors describing the attributes of alternative  $i$  and  $j$ , and

$\beta$  = vector of coefficients.

By differentiating equation (7.1), the marginal effect of an explanatory variable can be derived as:



$$\delta_i = \frac{\partial \pi_i}{\partial X_i} = \pi_i \left[ \beta_i - \sum_j \pi_j \beta_j \right] \quad (7.2)$$

where  $\pi(i)$  is the probability of a miller's choice of alternative  $i$

The marginal effect  $\delta_i$  in the question (7.2) measures the shifts in the probability of an outcome with respect to a change in a given regressor (i.e. factor), (Huang and Fu, 1995).

To interpret the marginal effect of explanatory variables (factor), two methods can be used. First, the marginal effect on event probability can be expressed as the partial derivative of probability  $\pi(i)$  with respect to  $X_i$  (Liao, 1994, p 45). However, a potential bias may exist in deriving the marginal effect by using partial derivatives for discrete choice variables, since taking partial derivatives with respect to a dummy variable tends to overestimate the marginal effect. Partial derivatives give only a rough approximation of the marginal effect of a dummy variable on probability while they give a close approximation of the marginal effect of a continuous variable on probability. Hence this method should be used only for an overall impression and with caution (Liao, 1994 p 47).

A better estimate of such a marginal effect can be computed by taking the difference of the predicted probability, conditional on each of two categories in the dummy variable (Liao, 1994 p 19). The values in the set of explanatory variable determine the level of the event probability, and the marginal effect of an explanatory variable on probability will vary with the level of the event probability. Therefore, deriving the difference between two predicted probabilities will generate the marginal probability with respect to a change in the level of an explanatory variable.

The predicted probabilities of choosing a product are calculated using a set of values for the factor variables (i.e. factor level). To calculate predicted probabilities, a specified level of each of the explanatory variable needs to be determined for choice A and choice B. In this study, the set of values of explanatory variables is chosen based on the definition of the preferred product profile for each product category (Tables 5.7 and 6.4). However, there is an exception in computing the marginal probabilities. In order to facilitate a better understanding of the marginal probabilities, it is assumed that the factor level for the price variable is fixed at the level of "no change" for all calculations of the marginal probabilities (Tables 7.1 to 7.6).

Two predicted probabilities that use different values for a particular variable and that use the same set of values for the rest of the explanatory variables (*ceteris paribus*) can be compared. The difference between these two predicted probabilities is interpreted as the marginal effect of the specific variable on the probability of miller's choice. For example, suppose that the marginal effect of change in ash level on the probability of miller's hard wheat choice is of interest. Calculation of two predicted probabilities can allow this (Tables 7.1a to 7.6a). Two predicted probabilities will be calculated at two different levels of ash content (i.e. ash content at 1.90 and 1.75 percent) for choice A only. Ash content remains unchanged for choice B. For choice A and choice B the level of falling



number and test weight are held constant. The level of the falling number and the test weight are based on the definition of the preferred product profiles. This means that the predicted probability of choice B is always derived from the factor levels of the preferred profiles, while the predicted probability of choice A is derived by applying different levels of ash content, holding the levels of other factors at the preferred levels. The differences between these two predicted probabilities indicate the marginal effect of a change in the level of ash content, *ceteris paribus*, on millers' choice behaviour. Therefore, the preferred profiles of wheat and flour (Tables 5.7 and 6.4) are used as the base case in the marginal analysis. The estimates of marginal probability are presented in Tables 7.1 to 7.6.

South Korea applies three classification categories for wheat. These are semi-hard wheat, medium wheat and soft wheat. These are graded based on protein content, ash content and moisture content. Japan has an additional category in classifying wheat classes. In Japan, wheat is categorized as hard wheat, semi-hard wheat, medium wheat and soft wheat. The hard wheat category in Japan has a higher level of protein compared to that in South Korea (Interview, 1999). The pre-survey interview indicates that the hard wheat category in South Korea has wheat quality characteristics that are comparable to the semi-hard wheat category, while the medium wheat category in South Korea is comparable to the medium wheat category in Japan with respect to its quality characteristics. In this study, the hard wheat category in South Korea is stated as "semi-hard wheat" in order to avoid potential confusion that may arise in comparing these two markets.

### **7.2.1 Ash Content, Falling Number and Test Weight**

Table 7.1 reports the calculated marginal effects of changes in specified quality factors in South Korea on the probability of miller's wheat choice. The specified factors for this purpose are ash content, falling number and test weight. Table 7.2 reports the marginal effects of quality changes in ash content, falling number and test weight in Japan.

For the medium wheat category, the probability of Korean millers' purchase increases by 0.23 when the ash level decreases from 1.85 to 1.70 percent (Table 7.1). The probability of purchase of medium wheat by Japanese millers increases by 0.05 for an equivalent decrease in the ash level. For the semi-hard wheat category in South Korea, a decrease in the ash content from 1.90 to 1.75 percent gives the highest increase in the probability (0.27) of the millers making a purchase. In Japan a decrease in the ash content from 1.70 to 1.55 percent would create the largest increase (0.19) in the probability of the millers purchasing a semi-hard wheat (Table 7.2).

For falling number, the probability of Korean millers making a purchase of medium wheat increases by 0.26 when the falling number increases from 300 to 337. The probability of purchase of medium wheat by Japanese millers increases by 0.18 for a rise in the falling number from 250 to 300. This suggests that an improvement in the condition of the falling number of wheat would have a substantial impact on millers' purchase behavior in both countries. However, Japanese millers' probability of purchase



of semi- hard wheat decreases by 0.03 when the falling number increases from 337 to 380. If exporters attempt to improve the condition of the falling number in the semi-hard wheat, they need to be careful not to exceed the preferred range of falling number, which is between 250 and 337.

The probability of purchasing semi-hard wheat by Korean millers increases by 0.32 when the test weight of wheat increases from 73 to 77. This probability of purchase decreases by 0.07 when the test weight increases from 80 to 84 (Table 7.1). The probability of purchasing semi-hard wheat by Japanese millers increases by 0.17 when the test weight increases from 75 to 79. However, the probability of purchase of semi-hard wheat decreases by 0.02 if the test weight increases from 82 to 86 (Table 7.2). Korean millers are more responsive to change in test weight than are Japanese millers for both semi-hard wheat and medium wheat categories.

### ***7.2.2 Protein Content and Dockage Level***

Korean and Japanese millers show different reactions to changes in the level of protein content. An increase in the protein level from 10.8 to 11.5 percent increases the probability of Korean millers purchasing semi-hard wheat by 0.23. This probability increases by 0.08 if the protein level increases from 11.5 to 12.2 percent (Table 7.3). The probability of Japanese millers buying semi-hard wheat increases by 0.05 if the protein level increases from 10.2 to 11.0 percent. The probability of purchase increases by 0.26 if the protein level increases from 11.0 to 12.0 percent (Table 7.4). It can be concluded that Japanese millers place a greater value on a protein content increase from 11.0 to 12.0 percent, while Korean millers place greater value on a change in the protein level from 10.8 to 11.5 percent. Japanese millers appear to prefer a higher level of protein for semi-hard wheat. In developing noodle wheat for the semi-hard wheat class, exporters should be aware of this discrepancy in Japanese and Korean millers' preferences for protein content.

For medium wheat, Japanese and Korean millers also show different preferences for protein level. With an increase in the protein level from 9.5 to 10.2 percent, Japanese millers' probability of wheat purchase increases by 0.05 while the probability of purchase of medium wheat increases by 0.07 if the protein level rises from 10.2 to 10.7 percent. In Korea, millers' probability of wheat purchase increases by 0.18 with a rise in the protein level from 9.5 to 10.2 percent. The probability of purchase of medium wheat by Korean millers would increase by 0.16 for a rise in the protein level from 10.2 to 10.7 percent.

Millers in both Japan and South Korea exhibit negative reactions to a rise in the protein content from 10.7 to 11.5 percent for medium wheat. Korean millers' probability of wheat purchase decreases by 0.19 for such an increase in the protein level. For the same protein change, the probability of purchase of medium wheat by Japanese millers decreases by 0.05. Thus a higher level of protein content does not necessarily result in an increased probability of purchase by millers in Japan and South Korea. It is important to increase the protein level to add value to the medium wheat class, but this must be done within the range which is revealed through the marginal probabilities. Korean millers are more responsive than Japanese millers to changes in protein levels. This suggests that the



potential benefit to an exporter from an increase in the protein content of a medium wheat could be greater in the Korean market than the Japanese market.

A decrease in the dockage level from 0.4 to 0.2 percent tends to increase Korean millers' probability of purchasing a semi-hard wheat by 0.30. The same change in the dockage level will increase Japanese millers' probability of choice for the semi-hard wheat by 0.15 (Table 7.3 and 7.4).

Overall, millers in Japan and South Korea exhibit different responses to a quality change represented by a change in wheat protein content. For semi-hard wheat, Japanese millers appear to be more responsive to a higher level of protein than Korean millers. For medium wheat, Korean millers are more responsive than Japanese millers to changes in protein levels. Korean millers are also more responsive in increasing their likelihood of purchase in responses to a change in the dockage level of semi-hard compared to Japanese millers. In summary, for protein content and ash content, millers in Japan and South Korea show different responses to changes in the quality level represented by changes in these factors. Although millers in both countries generally exhibit a similar pattern in their reaction to particular levels of the quality factors of falling number, dockage level and test weight, Korean millers respond to the quality changes to a greater extent than do Japanese millers.

### *7.2.3 Effect of Country of Origin*

The difference between two predicted probabilities based on different countries of origin can be viewed to reflect the relative "brand" image of wheat from two countries. This "brand" image of country of origin will implicitly reflect quality factors that are service related and general country image (Unterschultz et al, 1998).

For medium wheat, Japanese and Korean millers have distinct differences in preferences for country of origin. When the origin changes from U.S. to Canadian wheat, Korean millers' probability of product purchase increases by 0.03, while Japanese millers' probability of product purchase decreases by 0.07.

When the origin of wheat changes from Canada to Australia, the probability of medium wheat purchases by Korean millers increases by 0.05 percent, and Japanese millers' probability of the medium wheat purchase increases by 0.19 percent. For this product category, Korean millers would decrease their likelihood of purchase by 0.32 percent, while Japanese millers would decrease their likelihood of purchase by 0.04 percent when the origin changes from Australia to the U.S.

For semi-hard wheat, the magnitude of the marginal probabilities is higher in Korea than in Japan. It appears that Korean millers are more responsive to the origin of semi-hard wheat product than are Japanese millers. The probability of purchase of semi-hard wheat by Korean millers decreases by 0.14 when the origin changes from the U.S. to Canada. For the same change in the origin, the probability of wheat purchase by Japanese millers decreases by 0.02.



When the origin of wheat changes from Canada to Australia, the likelihood of purchase of wheat by Korean millers increases by 0.28, and the likelihood of purchase by Japanese millers increases by 0.03. Korean millers' probability of purchase decreases by 0.43 when the origin changes from Australia to the U.S. For the same change in the origin, Japanese millers' probability of purchase of wheat decreases by 0.12.

#### ***7.2.4 Ash Content, Color and Amylograph for Flour Quality***

When ash content decreases from 0.38 to 0.35 percent, the probability of Korean millers choosing Udon flour increases by 0.51, and the probability of Japanese millers choosing this flour will increase by 0.29 (Table 7.5 and 7.6). For Ramen flour, the probability of Korean millers' purchase increases by 0.36 percent if the ash content decreases from 0.43 to 0.41 percent. For a similar change in the ash content from (0.42 to 0.38 percent), Japanese millers' probability of purchase of Ramen flour increases by 0.08. Thus, Korean millers are more sensitive to the level of ash content in instant Ramen flour than are Japanese millers.

Millers in Japan and South Korea also show different reactions to a change in the level of color for instant Ramen flour. When the L value of color increases from 89 to 91, the probability of South Korean millers choosing an instant Ramen flour will increase by 0.48, while the probability of Japanese millers will increase by 0.14. Overall, the results on ash content and color values reveal that South Korean millers respond more to the condition of the color of noodle flour than Japanese millers.

### **7. 3 MARKETING IMPLICATIONS FOR WHEAT EXPORTERS**

#### ***7.3.1 Differences of Japanese and Korean Millers' Choice Behavior***

The qualitative pre-survey interviews and the results of the estimated models suggest the need for marketing efforts to be differentiated for these two different markets. The comparison of the marginal effects of changing the level of each factor on the probability of millers' wheat and flour choices for Japan versus South Korea shows some differences in millers' preferences in the two nations (Tables 7.1 to 7.6). Overall, the marginal effects of the quality factors of wheat and wheat flour on the millers' probability of choice were greater in South Korea than in Japan. Several factors may contribute to the difference in Japanese and Korean millers' choice behavior in response to quality changes of wheat and wheat flour.

One possible explanation for such differences is the difference in the organization of the wheat marketing systems in these two nations. The wheat marketing system in South Korea was privatized in 1990. Prior to 1990, a central buying agency, called the Korea Flour Mills Association (KOFMIA) regulated the importation of wheat. As South Korea privatized its wheat marketing system, millers were allowed to import wheat directly and they have tended to use more stringent and specific contract specifications than formerly (Interview, 1999). Private buyers may tend to develop more specificity in purchase contracts, as suggested by Wilson, since private buyers (millers) have a greater incentive to evaluate the value of wheat quality and can be more willing to pay a premium if that greater quality enhances their profits (Wilson, 2000). The marginal analysis reported here is consistent with the hypothesis that South Korean millers are more responsive than are



Japanese millers to changes in important quality factors for wheat and flour. However, Japanese millers are more sensitive to price changes.

Abbott and Young (1999) argue that the JFA tends to isolate Japanese domestic markets from world wheat market conditions and that private wheat traders in South Korea have a relatively high price elasticity of import demand for wheat importation. The findings of the study reported here are consistent with the conclusions drawn by Abbott and Young. The pre-survey interviews indicated that the levels of the price factor needed to be specified at different ranges for Japan than for South Korea. In the Japanese milling industry case, the levels specified were a 2 percent decrease from the previous price, a 1 percent decrease, no change in price and a 1 percent increase from the previous price. In the Korean case, the chosen levels were a 10 percent decrease from the previous price, a 5 percent decrease from the previous price, no change in price and a 5 percent increase from the previous price. Thus, there were differences in the range of price changes which were considered by millers in each nation to be appropriate for each market. This finding is consistent with the hypothesis that private buyers (millers) in South Korea are likely to be more willing to vary price in response to changes in wheat quality that affect their profits. This may suggest that quality improvements in wheat classes that are tailored for South Korean noodle market could result in a greater response by millers than would be expected in the Japanese market under the current marketing regime.

In Japan, the central buying agency, the Japan Food Agency (JFA) regulates the importation of wheat and does this through quota allocations and two tier pricing. Japanese millers are tertiary buyers who take the resale prices of imported wheat that are set by the JFA. The primary buyers of imported wheat in Japan are the grain traders who sell the imported wheat to the JFA, which is the secondary buyer. Japanese millers purchase imported wheat from the JFA at fixed resale prices on which a substantial mark-up is added. Since Japanese millers are insulated from international wheat prices and may request quality specifications from the JFA, millers in Japan could be hypothesized to be less willing to pay premiums for improvements in wheat quality. They also appear to be less responsive to changes in quality characteristics of wheat and flour. It is expected that Japanese imported wheat market may present a marketing opportunity for wheat exporting nations as the system in Japan become more open.

Differences in the choice behaviour between Japanese and Korean millers were also seen in the process of data collection. The Korean millers were able to respond to the semantic differential scale (SDS) component of the survey question, while the Japanese millers had difficulty in answering the SDS questions. After five interview sessions with Japanese millers, the SDS component of the survey was dropped from the Japanese version of the survey set. Japanese millers are used to the purchase of imported wheat with the quality specifications that have been provided by the JFA for the past three decades. The interviewer concluded that the respondents did not have the experience to evaluate the value of wheat quality over wider ranges of quality variation. It may be that the SDS questions required specific knowledge about each quality factor with range. The industry representatives who pre-tested the SDS questions of Japanese version are involved in the research and development (R/D) sections of the milling companies and they may



therefore have faced less difficulty in answering the SDS questions. However, the “average” industry respondents in Japan found the SDS questions difficult to answer.

It appears that Japanese millers are not accustomed to making purchase contracts of imported wheat that exhibit varying characteristics. This might be viewed as a marketing opportunity in Japan for exporting nations. Exporting nations could develop technical seminars in marketing programs to educate Japanese millers about specific nature of quality characteristics of wheat varieties that could be used in processing noodle flour. This marketing effort could enhance specific knowledge of each quality factors of wheat that are important to their purchase decisions. Increased levels of knowledge by Japanese millers on new wheat varieties through the technical seminars could result in increased preferences for these wheat varieties and potential increase in purchases of these wheat varieties as Japanese millers have more freedom and more experience in making purchase contracts for imported wheat.

Differences in the preferences for dockage levels by Japanese and Korean millers suggest that Korean millers are more stringent in the quality specifications that they apply in purchasing wheat. Although dockage level at 0.2 percent was specified as the lowest level for each wheat class and was preferred by millers in both Japan and South Korea, the levels of acceptance of dockage were different for Japanese and Korean millers. A level of dockage at 0.4 percent had a positive effect on the probability of purchase of wheat by Japanese millers, while this dockage level had a negative effect on the probability of wheat choices by Korean millers. Wheat dockage is a contract term subject to negotiation between buyers and sellers. Dockage differs from other quality attributes in that it can be controlled (removed) at several points in the marketing system. This factor is used by some exporting nations as a grade-determining factor, with stringent limits that make grain cleanliness a component of export strategy (Johnson and Wilson, 1995). The lower level of acceptance for dockage by Korean millers than Japanese millers suggests that Korean millers may be more stringent in negotiating contract terms with exporters. Given this feature of Korean millers’ behavior, there appear to be rewards for exporting extra-clean wheat to the South Korean market. Since quality evaluation of CWRS (13.5%) currently marketed from Canada shows this to have the lowest level of dockage (Table 5.10), Canada may be able to build on this strength in related efforts to extend its market position in the noodle wheat market in South Korea if other market specification can also be catered.

### ***7.3.2 Competitiveness of Wheat from Three Major Exporting Nations***

The estimated coefficients from the SPM analyses were used to determine the preferred product profiles of each wheat and flour categories in Japan and South Korea (Tables 5.7 and 6.4). The preferred product profiles are compared with the wheat classes that are currently offered in Japan and South Korea by three major exporters: the U.S., Australia and Canada (Tables 5.8, 5.9, 6.5 and 6.6). This comparison evaluates whether or not each exporting nation is developing and marketing their wheat according to the quality preferences stated by millers in Japan and South Korea.

In South Korea, the 100% Australian noodle wheat category is found to be closely matched with the quality specifications of medium wheat, while HRW (11.5%) of the



U.S. has protein content and falling number at much higher levels than the preferred levels (Table 7.7). Canada began to market CWRS that has lower level of protein content since 1998 (KOFMIA, 2000). Canada exported CWRS at 11.5% and 12.5% of protein content to South Korea in 1998 and 1999 to target the medium wheat market segment. For semi-hard wheat, there is no wheat class that match the quality profile preferred by Korean millers. AH from Australia and CWRS 13.5% from Canada both are targeted to the semi-hard wheat segment, but do not match the protein and the ash content preferred by Korean millers. DNS from the U.S. also has protein content (13.5%) that is higher than the preferred level (12.2%) and ash content (1.55%) that is higher than the preferred level (1.45%). WW from the U.S. meets the soft wheat profile preferred by Korean millers. AS from Australia has a protein content (8.7%) that is lower than preferred for soft wheat (9.5%) in South Korea. Canada does not export soft wheat to South Korean market. Australia exports the largest number of wheat categories, which may have helped to increase its market share in South Korea. Overall, Australia appears to be successful in positioning itself in the market segment for medium wheat, while the U.S. sells wheat with characteristics that are preferred in the smaller market segments for soft wheat (Table 7.7).

In Japan, the U.S. is competitive in both hard wheat and semi-hard wheat market segments (Table 7.7). Ash content and protein content of the DNS (14.0% protein) from the U.S. is reported to match the protein content and ash content preference for hard wheat expressed by Japanese millers. CWRS (13.5% protein) from Canada is too low in protein content and too high in ash content (1.57%) compared to the preferences stated by Japanese millers. APH (14.7% protein) from Australia has a higher level of protein than stated as the preferred level and a higher level of falling number (713) than stated as the preferred level (380). Canada and Australia currently do not have hard wheat or semi-hard wheat that closely meets the preferences for protein content and ash content. In the medium wheat category, ASW from Australia has quality characteristics that are close to the preferred profile stated by Japanese millers. In summary, the U.S. appears to have a competitive position, in this context, in the hard wheat and the semi-hard wheat market segments, while Australia is competitive in the characteristics of its wheat for the large market segment of medium wheat (Table 7.7).

### ***7.3.3 Brand Images for Three Wheat Exporting Nations***

The brand images of three major wheat-exporting nations in Japan and South Korea can be assessed based on the coefficient estimates from one of the three groups of multinomial logit (MNL) models (Tables 5.3 and 6.3). For both the semi-hard wheat and medium wheat categories, wheat of Australian origin is most preferred by South Korean millers. For the soft wheat category, wheat of U.S. origin is most preferred by Korean millers (Table 7.8). Canadian origin does not have a significant positive effect on Korean millers' preferences for imported wheat. For all three wheat categories, there was a negative impact on millers' wheat purchasing decision for wheat of South Korean origin.

In the Japanese market, wheat of Australian origin is most preferred by Japanese millers for semi-hard wheat and medium wheat classes (Table 7.8). For the hard wheat category, wheat of U.S. origin is most preferred by Japanese millers. Domestic origin has



significant positive effect on Japanese millers' preferences for the medium wheat category, while wheat that is of Canadian origin has significant positive effect on the millers' choice decisions for hard wheat.

Overall, Australia appears to have stronger brand image in both of the medium and the semi-hard wheat categories in these nations compared to the U.S. and Canada. Currently, Australia does not provide semi-hard wheat that closely meets the preferred quality profiles stated by Japanese and Korean millers. However, Australia was perceived to have the strongest brand image in the semi-hard wheat market segment. This may be due to the effective niche marketing emphasized by Australia in developing a medium class noodle wheat that meets these customers' quality specifications. This may have contributed to developing a positive brand image of Australia as a quality supplier in general. It is expected that a strong brand image of medium wheat of Australian origin would facilitate market penetration of semi-hard wheat of Australian origin to both Korean and Japanese markets.

Korean and Japanese millers appear to have differences in their preferences for the country of origin in purchasing medium wheat. For medium wheat, the U.S. appears to have a stronger brand image than Canada in Japan, while Canada has a stronger brand image compared to the U.S. in South Korea. Thus, for exportation of medium wheat, the U.S. may need to place more marketing efforts in South Korea to improve its brand image relative to Canada and Australia, while Canada needs to emphasize its marketing efforts in Japan to improve its brand image relative to the U.S. and Australia.

Alston et al (1989) and Esfahani (1995) argued that the Japanese government has managed wheat imports with quotas that favor the U.S. over other exporters due to the political and economical importance of the U.S. to Japan. They state that the Japan Food Agency's (JFA) political bias distorts the market share of each exporter. The results of this study are consistent with conclusions to this effect of previous studies (Alston et al 1990; Esfahani 1995; Wilson 1987). It was found that both Japanese and Korean millers prefer wheat of Australian origin to the U.S. and Canada for both semi-hard and medium wheat classes that are suitable for production of noodle flour (Table 7.8). However, Australia's market share has been approximately 20 percent in Japan during the period from 1976 1996, while the U.S. market share in Japan has been 57 percent during the same period (Table 2.10 and Table 7.9). Thus, the preferences for Australian origin by Japanese millers do not translate into the actual market share of Australia in Japan. With future privatization in the wheat marketing system in Japan, it could be expected that Australia could benefit through an increasing market share from market liberalization and the U.S. could lose market share.

In South Korea, the preferences for wheat of Australian origin by millers are currently reflected in the actual market shares of three exporting nations (Table 2.8 and Table 7.9). The market share of the U.S. decreased from 100 percent to 68 percent from 1970 to 1996, while the market share of Australia increased rapidly from zero percent to 29 percent and then almost to 40 percent in 1970, 1996 and 1999, respectively. It appears



that the privatization of the wheat marketing system in South Korea resulted in appreciable changes in import market shares for wheat.

Canada seems to have a stronger brand image relative to the U.S. in South Korea for medium wheat, while the U.S. has a stronger brand image than Canada for the semi-hard wheat. Canadian wheat has been claimed to have certain characteristics preferred by importers, mostly related to cleanliness and uniformity due to its stringent grading system (Bruce and Wilson, 2000). Since the private buyers (millers) in South Korea tend to use a more stringent and comprehensive set of specifications in their purchase contracts and reward extra-clean wheat, Canada may be able to use the cleanliness and consistency of Canadian wheat as a major feature of its wheat marketing strategy in South Korea.

The U.S. has exported wheat to South Korea since 1959, while Canada and Australia began their exportation of wheat to Korea in 1983. Canada has a relatively weaker position than the U.S. and Australia in the South Korean market with respect to semi-hard and soft wheat categories, and will require much marketing effort to improve its image. Nonetheless, the South Korean market could be viewed to be promising from a Canadian perspective since Korean millers are more responsive than Japanese millers to quality improvements in wheat classes that are used in producing noodle flour.

Coefficient estimates of the MNL models for the Japanese market indicate Japanese millers' preference for U.S. origin over Canadian origin for both semi-hard and medium wheat classes. Canada was a stable supplier of Canadian winter red spring (CWRS) that has protein level at 13.5 percent to Japan from 1972 to 1997 (Table 2.10). This has been mainly used in milling bread flour. CWRS 13.5 percent has been recently used in processing some Chinese fresh noodles (Interview, 2000). Canadian wheat market share in Japan has been maintained at 25 percent during this period. However, Canadian exporters may need to extend their marketing efforts in Japan as Japan's wheat market deregulates. As the wheat marketing system gradually deregulates in Japan, the preference for wheat of Australian and U.S. origins over Canadian-origin wheat by Japanese millers in purchasing semi-hard and medium wheat could be realized, resulting in a transfer of market share from Canada either to Australia or the U.S.

As discussed earlier in this section, Canadian exporters could emphasize technical seminars in marketing programs to increase awareness of Japanese millers on specific quality factors of wheat classes that could be used in noodle processing. As the wheat marketing system in Japan becomes privatized, Japanese millers are expected to have more freedom in negotiating purchase contracts of imported wheat. This may lead to Japanese millers becoming more responsive to and stringent in their quality specifications for imported wheat. Since Canada is perceived as an exporter of high-quality wheat which is suitable for production of bread flour, Canada may be able to use this image to extend its market share in the noodle wheat segment in Japan. This will require Canada to develop wheat varieties appropriate for this market.



**Table 7.1 Marginal Analysis on the Quality Attributes of Wheat in the Korean Market**

| Factor<br>/a, b, c | Semi-hard Wheat |                      | Medium Wheat    |                      | Soft Wheat      |                      |
|--------------------|-----------------|----------------------|-----------------|----------------------|-----------------|----------------------|
|                    | Change in level | Marginal Probability | Change in level | Marginal Probability | Change in level | Marginal Probability |
| <b>Ash content</b> |                 |                      |                 |                      |                 |                      |
|                    | 1.90% to 1.75%  | 0.27                 | 1.85% to 1.70%  | 0.23                 | 1.85% to 1.75%  | 0.09                 |
|                    | 1.75% to 1.60%  | 0.01                 | 1.70%to 1.55%   | 0.20                 | 1.75%to 1.55%   | 0.31                 |
|                    | 1.60%to 1.45%   | 0.08                 | 1.55%to 1.45%   | -0.11                | 1.55% to 1.45%  | -0.12                |
| <b>Falling No.</b> |                 |                      |                 |                      |                 |                      |
|                    | 250 to 300      | 0.30                 | 250 to 300      | 0.17                 | 250 to 300      | 0.25                 |
|                    | 300 to 337      | 0.13                 | 300 to 337      | 0.26                 | 300 to 337      | 0.20                 |
|                    | 337 to 380      | 0.05                 | 337 to 380      | 0.05                 | 337 to 380      | 0.03                 |
| <b>Test weight</b> |                 |                      |                 |                      |                 |                      |
|                    | 73 to 77        | 0.32                 | 75 to 79        | 0.12                 | 75 to 77        | 0.06                 |
|                    | 77 to 80        | -0.01                | 79 to 82        | 0.20                 | 77 to 80        | 0.18                 |
|                    | 80 to 84        | -0.07                | 82 to 86        | -0.05                | 80 to 84        | -0.12                |

/a Two predicted probabilities that use different values for a particular variable and that use the same set of values for the rest of the explanatory variables (*ceteris paribus*) are compared to derive the marginal probability of change in the level of a factor. The difference between these two predicted probabilities is interpreted as the marginal effect of the specific variable on the probability of miller's choice. To calculate predicted probabilities, a specified level of each of the explanatory variable needs to be determined for choice A and choice B. The factor levels that are identified from preferred product profiles are used as the base case (choice B).

/b note that the factor level for the price variable is fixed at the level of "no change" for all calculations of the marginal probabilities.

/c note that marginal probabilities are derived from taking differences between total probabilities of choice A and choice B (Table 7.1 a).



**Table 7.1a Predicted Probabilities of Choices A and B for the Quality Attributes of Wheat in the Korean Market**

| /c                    | Semi-hard Wheat |                         |             | Medium Wheat |                         |             | Soft Wheat   |                         |             |
|-----------------------|-----------------|-------------------------|-------------|--------------|-------------------------|-------------|--------------|-------------------------|-------------|
|                       | Factor Level    | Predicted probabilities |             | Factor Level | Predicted probabilities |             | Factor Level | Predicted probabilities |             |
|                       |                 | Choice A /a             | Choice B /b |              | Choice A /a             | Choice B /b |              | Choice A /a             | Choice B /b |
| <b>Ash content</b>    | 1.90%           | 0.13                    | 0.82        | 1.85%        | 0.06                    | 0.92        | 1.85%        | 0.09                    | 0.87        |
|                       | 1.75%           | 0.40                    | 0.57        | 1.70%        | 0.29                    | 0.69        | 1.75%        | 0.18                    | 0.79        |
|                       | 1.60%           | 0.41                    | 0.56        | 1.55%        | 0.49                    | 0.49        | 1.55%        | 0.49                    | 0.49        |
|                       | 1.45%           | 0.49                    | 0.49        | 1.45%        | 0.39                    | 0.60        | 1.45%        | 0.37                    | 0.60        |
| <b>Falling number</b> | 250             | 0.004                   | 0.94        | 250          | 0.01                    | 0.96        | 250          | 0.01                    | 0.95        |
|                       | 300             | 0.30                    | 0.66        | 300          | 0.18                    | 0.80        | 300          | 0.26                    | 0.71        |
|                       | 337             | 0.44                    | 0.53        | 337          | 0.44                    | 0.55        | 337          | 0.46                    | 0.51        |
|                       | 380             | 0.49                    | 0.49        | 380          | 0.49                    | 0.49        | 380          | 0.49                    | 0.49        |
| <b>Test weight</b>    | 73              | 0.17                    | 0.79        | 75           | 0.17                    | 0.80        | 75           | 0.25                    | 0.72        |
|                       | 77              | 0.49                    | 0.49        | 79           | 0.29                    | 0.69        | 77           | 0.31                    | 0.66        |
|                       | 80              | 0.48                    | 0.50        | 82           | 0.49                    | 0.49        | 80           | 0.49                    | 0.49        |
|                       | 84              | 0.40                    | 0.56        | 86           | 0.44                    | 0.54        | 84           | 0.36                    | 0.61        |

/a Predicted probabilities of choice A varies as the level of each factor changes, ceteris paribus.

/b The factor levels in choice B are held constant based on the definition of the preferred profile (Table 5.7). Therefore, predicted probabilities of choice B are used as the base.

/c The predicted probabilities of choice A are used to derive marginal probabilities of change in a particular factor level (Table 7.1).



**Table 7.2 Marginal Analysis on the Quality Attributes of Wheat in the Japanese Market**

| Factor<br>/a, b, c | Hard Wheat         |                         | Semi-Hard Wheat   |                         | Medium Wheat      |                         |
|--------------------|--------------------|-------------------------|-------------------|-------------------------|-------------------|-------------------------|
|                    | Change in<br>level | Marginal<br>Probability | Factor level      | Marginal<br>Probability | Factor level      | Marginal<br>Probability |
| <b>Ash content</b> |                    |                         |                   |                         |                   |                         |
|                    | 1.90% to<br>1.75%  | 0.09                    | 1.85% to<br>1.70% | 0.06                    | 1.85% to<br>1.75% | 0.05                    |
|                    | 1.75% to<br>1.60%  | 0.27                    | 1.70%to<br>1.55%  | 0.19                    | 1.75%to<br>1.55%  | 0.35                    |
|                    | 1.60%to<br>1.45%   | -0.02                   | 1.55%to<br>1.45%  | 0.14                    | 1.55% to<br>1.45% | -0.01                   |
| <b>Falling No.</b> |                    |                         |                   |                         |                   |                         |
|                    | 250 to 300         | 0.32                    | 250 to 300        | 0.27                    | 250 to 300        | 0.18                    |
|                    | 300 to 337         | -0.04                   | 300 to 337        | 0.11                    | 300 to 337        | 0.04                    |
|                    | 337 to 380         | 0.01                    | 337 to 380        | -0.03                   | 337 to 380        | 0.09                    |
| <b>Test weight</b> |                    |                         |                   |                         |                   |                         |
|                    | 73 to 77           | 0.12                    | 75 to 79          | 0.17                    | 75 to 77          | 0.08                    |
|                    | 77 to 80           | 0.21                    | 79 to 82          | 0.14                    | 77 to 80          | 0.15                    |
|                    | 80 to 84           | 0.08                    | 82 to 86          | -0.02                   | 80 to 84          | -0.01                   |

/a Two predicted probabilities that use different values for a particular variable and that use the same set of values for the rest of the explanatory variables (*ceteris paribus*) are compared to derive the marginal probability of change in the level of a factor. The difference between these two predicted probabilities is interpreted as the marginal effect of the specific variable on the probability of miller's choice. To calculate predicted probabilities, a specified level of each of the explanatory variable needs to be determined for choice A and choice B. The factor levels that are identified from preferred product profiles are used as the base case (choice B).

/b Note that the factor level for the price variable is fixed at the level of "no change" for all calculations of the marginal probabilities.

/c note that marginal probabilities are derived from taking differences between total probabilities of choice A and choice B (Table 7.2 a).



**Table 7.2a Predicted Probabilities of Choices A and B for the Quality Attributes of Wheat in the Japanese Market**

| /c             | Hard Wheat   |                         | Semi-hard Wheat |              | Medium Wheat            |             |
|----------------|--------------|-------------------------|-----------------|--------------|-------------------------|-------------|
|                | Factor Level | Predicted probabilities |                 | Factor Level | Predicted probabilities |             |
| Ash content    |              | Choice A /a             | Choice B /b     |              | Choice A /a             | Choice B /b |
|                | 1.90%        | 0.12                    | 0.80            | 1.85%        | 0.08                    | 0.83        |
|                | 1.75%        | 0.21                    | 0.72            | 1.70%        | 0.15                    | 0.78        |
|                | 1.60%        | 0.48                    | 0.48            | 1.55%        | 0.34                    | 0.61        |
|                | 1.45%        | 0.45                    | 0.50            | 1.45%        | 0.48                    | 0.48        |
| Falling number | 250          | 0.18                    | 0.75            | 250          | 0.10                    | 0.82        |
|                | 300          | 0.50                    | 0.46            | 300          | 0.37                    | 0.57        |
|                | 337          | 0.46                    | 0.49            | 337          | 0.48                    | 0.48        |
|                | 380          | 0.48                    | 0.48            | 380          | 0.45                    | 0.50        |
| Test weight    | 73           | 0.06                    | 0.85            | 75           | 0.17                    | 0.75        |
|                | 77           | 0.18                    | 0.74            | 77           | 0.34                    | 0.60        |
|                | 80           | 0.40                    | 0.55            | 80           | 0.48                    | 0.48        |
|                | 84           | 0.48                    | 0.48            | 84           | 0.46                    | 0.49        |

/a Predicted probabilities of choice A varies as the level of each factor changes, ceteris paribus.

/b The factor levels in choice B are held constant based on the definition of the preferred profile (Table 6.4). Therefore, predicted probabilities of choice B are used as the base.

/c The predicted probabilities of choice A are used to derive marginal probabilities of change in a particular factor level (Table 7.2).



**Table 7.3 Marginal Analysis on the Quality Attributes of Wheat in the Korean Market**

| Factor<br>/a, b, c | Semi-hard wheat       |                      | Medium wheat          |                      | Soft wheat            |                      |
|--------------------|-----------------------|----------------------|-----------------------|----------------------|-----------------------|----------------------|
|                    | Change in level       | Marginal Probability | Change in level       | Marginal Probability | Change in level       | Marginal Probability |
| <b>Protein</b>     |                       |                      |                       |                      |                       |                      |
|                    | 10.8% to 11.5%        | 0.23                 | 9.5% to 10.2%         | 0.18                 | 8.5% to 9.0%          | -0.08                |
|                    | 11.5% to 12.2%        | 0.08                 | 10.2% to 10.7%        | 0.16                 | 9.0% to 9.5%          | 0.25                 |
|                    | 12.2% to 12.8%        | -0.02                | 10.7% to 11.5%        | -0.19                | 9.5% to 10.0%         | -0.22                |
| <b>Origin</b>      |                       |                      |                       |                      |                       |                      |
|                    | The U.S to Canada     | -0.14                | The U.S to Canada     | 0.03                 | The U.S to Canada     | -0.09                |
|                    | Canada to Australia   | 0.28                 | Canada to Australia   | 0.05                 | Canada to Australia   | 0.05                 |
|                    | Australia to the U.S. | -0.43                | Australia to the U.S. | -0.32                | Australia to the U.S. | -0.20                |
| <b>Dockage</b>     |                       |                      |                       |                      |                       |                      |
|                    | 0.8 to 0.6            | 0.08                 | 0.8 to 0.6            | 0.11                 | 0.8 to 0.6            | -0.19                |
|                    | 0.6 to 0.4            | 0.003                | 0.6 to 0.4            | -0.04                | 0.6 to 0.4            | 0.12                 |
|                    | 0.4 to 0.2            | 0.30                 | 0.4 to 0.2            | 0.20                 | 0.4 to 0.2            | 0.12                 |

/a Two predicted probabilities that use different values for a particular variable and that use the same set of values for the rest of the explanatory variables (*ceteris paribus*) are compared to derive the marginal probability of change in the level of a factor. The difference between these two predicted probabilities is interpreted as the marginal effect of the specific variable on the probability of miller's choice. To calculate predicted probabilities, a specified level of each of the explanatory variable needs to be determined for choice A and choice B. The factor levels that are identified from preferred product profiles are used as the base case (choice B).

/b Note that the factor level for the price variable is fixed at the level of "no change" for all calculations of the marginal probabilities.

/c note that marginal probabilities are derived from taking differences between total probabilities of choice A and choice B (Table 7.3 a).



**Table 7.3a Predicted Probabilities of Choices A and B for the Quality Attributes of Wheat in the Korean Market**

| /c                | Semi-hard Wheat |                         |             | Medium Wheat |                         |             | Soft Wheat   |                         |             |
|-------------------|-----------------|-------------------------|-------------|--------------|-------------------------|-------------|--------------|-------------------------|-------------|
|                   | Factor Level    | Predicted probabilities |             | Factor Level | Predicted probabilities |             | Factor Level | Predicted probabilities |             |
| Protein           |                 | Choice A /a             | Choice B /b |              | Choice A /a             | Choice B /b |              | Choice A /a             | Choice B /b |
|                   | 10.8%           | 0.17                    | 0.79        | 9.5%         | 0.14                    | 0.78        | 8.5%         | 0.28                    | 0.79        |
|                   | 11.5%           | 0.41                    | 0.56        | 10.2%        | 0.32                    | 0.61        | 9.0%         | 0.20                    | 0.79        |
|                   | 12.2%           | 0.49                    | 0.49        | 10.7%        | 0.47                    | 0.47        | 9.5%         | 0.45                    | 0.45        |
|                   | 12.8%           | 0.47                    | 0.50        | 11.5%        | 0.29                    | 0.64        | 10.0%        | 0.24                    | 0.64        |
| Country of Origin |                 |                         |             |              |                         |             |              |                         |             |
|                   | The U.S.        | 0.34                    | 0.63        | The U.S.     | 0.39                    | 0.55        | The U.S.     | 0.45                    | 0.45        |
|                   | Canada          | 0.20                    | 0.76        | Canada       | 0.42                    | 0.52        | Canada       | 0.36                    | 0.53        |
|                   | Australia       | 0.49                    | 0.49        | Australia    | 0.47                    | 0.47        | Australia    | 0.42                    | 0.49        |
| Dockage           | Domestic        | 0.05                    | 0.90        | Domestic     | 0.15                    | 0.76        | Domestic     | 0.22                    | 0.65        |
|                   | 0.8             | 0.10                    | 0.85        | 0.8          | 0.18                    | 0.74        | 0.8          | 0.40                    | 0.50        |
|                   | 0.6             | 0.18                    | 0.78        | 0.6          | 0.28                    | 0.64        | 0.6          | 0.21                    | 0.66        |
|                   | 0.4             | 0.19                    | 0.77        | 0.4          | 0.27                    | 0.66        | 0.4          | 0.33                    | 0.56        |
|                   | 0.2             | 0.49                    | 0.49        | 0.2          | 0.47                    | 0.47        | 0.2          | 0.45                    | 0.45        |

/a Predicted probabilities of choice A varies as the level of each factor changes, *ceteris paribus*.

/b The factor levels in choice B are held constant based on the definition of the preferred profile (Table 5.7). Therefore, predicted probabilities of choice B are used as the base.

/c The predicted probabilities of choice A are used to derive marginal probabilities of change in a particular factor level (Table 7.3).



**Table 7.4 Marginal Analysis on the Quality Attributes of wheat in the Japanese Market**

| Factor<br>/a, b, c | Hard wheat            |                      | Semi-Hard wheat       |                      | Medium wheat          |                      |
|--------------------|-----------------------|----------------------|-----------------------|----------------------|-----------------------|----------------------|
|                    | Change in level       | Marginal Probability | Change in level       | Marginal Probability | Change in level       | Marginal Probability |
| <b>Protein</b>     |                       |                      |                       |                      |                       |                      |
|                    | 12.0% to 12.7%        | 0.08                 | 10.2% to 11.0%        | 0.05                 | 9.5% to 10.2%         | 0.05                 |
|                    | 12.7% to 13.5%        | 0.21                 | 11.0% to 12.0%        | 0.26                 | 10.2% to 10.7%        | 0.07                 |
|                    | 13.5% to 14.0%        | 0.02                 | 12.0% to 12.8%        | -0.05                | 10.7% to 11.5%        | -0.03                |
| <b>Origin</b>      |                       |                      |                       |                      |                       |                      |
|                    | U.S to Canada         | -0.037               | U.S to Canada         | -0.02                | U.S to Canada         | -0.07                |
|                    | Canada to Australia   | -0.078               | Canada to Australia   | 0.03                 | Canada to Australia   | 0.19                 |
|                    | Australia to the U.S. | -0.072               | Australia to the U.S. | -0.12                | Australia to the U.S. | -0.04                |
| <b>Dockage</b>     |                       |                      |                       |                      |                       |                      |
|                    | 0.8 to 0.6            | 0.08                 | 0.8 to 0.6            | 0.05                 | 0.8 to 0.6            | 0.09                 |
|                    | 0.6 to 0.4            | 0.11                 | 0.6 to 0.4            | 0.13                 | 0.6 to 0.4            | 0.13                 |
|                    | 0.4 to 0.2            | 0.13                 | 0.4 to 0.2            | 0.15                 | 0.4 to 0.2            | 0.15                 |

/a Two predicted probabilities that use different values for a particular variable and that use the same set of values for the rest of the explanatory variables (*ceteris paribus*) are compared to derive the marginal probability of change in the level of a factor. The difference between these two predicted probabilities is interpreted as the marginal effect of the specific variable on the probability of miller's choice. To calculate predicted probabilities, a specified level of each of the explanatory variable needs to be determined for choice A and choice B. The factor levels that are identified from preferred product profiles are used as the base case (choice B).

/b Note that the factor level for the price variable is fixed at the level of "no change" for all calculations of the marginal probabilities.

/c note that marginal probabilities are derived from taking differences between total probabilities of choice A and choice B (Table 7.4 a).



**Table 7.4a Predicted Probabilities of Choices A and B for the Quality Attributes of wheat in the Japanese Market**

| /c                       | Hard Wheat   |                         |             | Semi-hard Wheat |                         |             | Medium Wheat |                         |             |
|--------------------------|--------------|-------------------------|-------------|-----------------|-------------------------|-------------|--------------|-------------------------|-------------|
|                          | Factor Level | Predicted probabilities |             | Factor Level    | Predicted probabilities |             | Factor Level | Predicted probabilities |             |
|                          |              | Choice A /a             | Choice B /b |                 | Choice A /a             | Choice B /b |              | Choice A /a             | Choice B /b |
| <b>Protein</b>           |              |                         |             |                 |                         |             |              |                         |             |
|                          | 12.0%        | 0.15                    | 0.74        | 10.2%           | 0.16                    | 0.72        | 9.5%         | 0.33                    | 0.56        |
|                          | 12.7%        | 0.23                    | 0.67        | 11.0%           | 0.21                    | 0.68        | 10.2%        | 0.38                    | 0.52        |
|                          | 13.5%        | 0.44                    | 0.49        | 12.0%           | 0.46                    | 0.46        | 10.7%        | 0.46                    | 0.46        |
|                          | 14.0%        | 0.46                    | 0.46        | 12.8%           | 0.41                    | 0.51        | 11.5%        | 0.43                    | 0.48        |
| <b>Country of Origin</b> |              |                         |             |                 |                         |             |              |                         |             |
|                          | The U.S.     | 0.46                    | 0.46        | The U.S.        | 0.45                    | 0.47        | The U.S.     | 0.34                    | 0.56        |
|                          | Canada       | 0.43                    | 0.50        | Canada          | 0.43                    | 0.49        | Canada       | 0.27                    | 0.62        |
|                          | Australia    | 0.35                    | 0.56        | Australia       | 0.46                    | 0.46        | Australia    | 0.46                    | 0.46        |
|                          | Domestic     | 0.28                    | 0.63        | Domestic        | 0.35                    | 0.56        | Domestic     | 0.42                    | 0.49        |
| <b>Dockage</b>           |              |                         |             |                 |                         |             |              |                         |             |
|                          | 0.8          | 0.15                    | 0.74        | 0.8             | 0.13                    | 0.75        | 0.8          | 0.09                    | 0.77        |
|                          | 0.6          | 0.23                    | 0.67        | 0.6             | 0.18                    | 0.71        | 0.6          | 0.17                    | 0.69        |
|                          | 0.4          | 0.34                    | 0.57        | 0.4             | 0.31                    | 0.59        | 0.4          | 0.31                    | 0.59        |
|                          | 0.2          | 0.46                    | 0.46        | 0.2             | 0.46                    | 0.46        | 0.2          | 0.46                    | 0.46        |

/a Predicted probabilities of choice A varies as the level of each factor changes, ceteris paribus.

/b The factor levels in choice B are held constant based on the definition of the preferred profile (Table 6.4). Therefore, predicted probabilities of choice B are used as the base.

/c The predicted probabilities of choice A are used to derive marginal probabilities of change in a particular factor level (Table 7.4).



**Table 7.5 Marginal Analysis on the Quality Attributes of Flour in the Korean Market**

| Factor<br>/a, b, c | Udon flour         |                         | Dry noodle flour   |                         | Ramen flour        |                         |
|--------------------|--------------------|-------------------------|--------------------|-------------------------|--------------------|-------------------------|
|                    | Change in<br>level | Marginal<br>Probability | Change in<br>level | Marginal<br>Probability | Change in<br>level | Marginal<br>Probability |
| Ash content        | 0.38% to<br>0.36%  | 0.25                    | 0.45% to<br>0.43%  | 0.19                    | 0.45% to<br>0.43%  | 0.09                    |
|                    | 0.36% to<br>0.34%  | -0.03                   | 0.43% to<br>0.41%  | 0.03                    | 0.43% to<br>0.41%  | 0.14                    |
|                    | 0.34% to<br>0.32%  | 0.11                    | 0.41% to<br>0.38%  | 0.22                    | 0.41% to<br>0.38%  | 0.20                    |
| Color              | 89 to 91           | 0.14                    | 89 to 91           | 0.17                    | 89 to 91           | 0.25                    |
|                    | 91 to 93           | 0.14                    | 91 to 93           | 0.18                    | 91 to 93           | -0.14                   |
|                    | 93 to 95           | -0.07                   | 93 to 95           | -0.17                   | 93 to 95           | -0.07                   |
| Amylograph         | 700 to 870         | 0.10                    | 500 to 730         | 0.33                    | 500 to 730         | 0.30                    |
|                    | 870 to 1040        | 0.17                    | 730 to 960         | 0.09                    | 730 to 960         | 0.07                    |
|                    | 1040 to<br>1200    | 0.01                    | 960 to 1200        | -0.09                   | 960 to 1200        | 0.03                    |

/a Two predicted probabilities that use different values for a particular variable and that use the same set of values for the rest of the explanatory variables (*ceteris paribus*) are compared to derive the marginal probability of change in the level of a factor. The difference between these two predicted probabilities is interpreted as the marginal effect of the specific variable on the probability of miller's choice. To calculate predicted probabilities, a specified level of each of the explanatory variable needs to be determined for choice A and choice B. The factor levels that are identified from preferred product profiles are used as the base case (choice B).

/b Note that the factor level for the price variable is fixed at the level of "no change" for all calculations of the marginal probabilities.

/c note that marginal probabilities are derived from taking differences between total probabilities of choice A and choice B (Table 7.5 a).



**Table 7.5a Predicted Probabilities of Choices A and B for the Quality Attributes of Flour in the Korean Market**

| /c                 | Udon Flour   |                         |             | Dry noodle Flour |                         |             | Ramen Flour  |                         |             |
|--------------------|--------------|-------------------------|-------------|------------------|-------------------------|-------------|--------------|-------------------------|-------------|
|                    | Factor Level | Predicted probabilities |             | Factor Level     | Predicted probabilities |             | Factor Level | Predicted probabilities |             |
|                    |              | Choice A /a             | Choice B /b |                  | Choice A /a             | Choice B /b |              | Choice A /a             | Choice B /b |
| <b>Ash content</b> | 0.38%        | 0.13                    | 0.74        | 0.45%            | 0.53                    | 0.90        | 0.45%        | 0.06                    | 0.88        |
|                    | 0.36%        | 0.38                    | 0.53        | 0.43%            | 0.24                    | 0.72        | 0.43%        | 0.15                    | 0.80        |
|                    | 0.34%        | 0.35                    | 0.55        | 0.41%            | 0.27                    | 0.69        | 0.41%        | 0.28                    | 0.67        |
|                    | 0.32%        | 0.46                    | 0.46        | 0.38%            | 0.49                    | 0.49        | 0.38%        | 0.48                    | 0.48        |
| <b>Color</b>       | 89           | 0.18                    | 0.70        | 89               | 0.14                    | 0.82        | 89           | 0.23                    | 0.71        |
|                    | 91           | 0.32                    | 0.58        | 91               | 0.31                    | 0.66        | 91           | 0.48                    | 0.48        |
|                    | 93           | 0.46                    | 0.46        | 93               | 0.49                    | 0.49        | 93           | 0.34                    | 0.62        |
|                    | 95           | 0.39                    | 0.52        | 95               | 0.31                    | 0.66        | 95           | 0.27                    | 0.68        |
| <b>Amylograph</b>  | 700          | 0.17                    | 0.71        | 500              | 0.07                    | 0.88        | 500          | 0.08                    | 0.86        |
|                    | 870          | 0.28                    | 0.62        | 730              | 0.40                    | 0.57        | 730          | 0.38                    | 0.58        |
|                    | 1040         | 0.45                    | 0.47        | 960              | 0.48                    | 0.48        | 960          | 0.45                    | 0.51        |
|                    | 1200         | 0.46                    | 0.46        | 1200             | 0.40                    | 0.57        | 1200         | 0.48                    | 0.48        |

/a Predicted probabilities of choice A varies as the level of each factor changes, ceteris paribus.

/b The factor levels in choice B are held constant based on the definition of the preferred profile (Table 5.7). Therefore, predicted probabilities of choice B are used as the base.

/c The predicted probabilities of choice A are used to derive marginal probabilities of change in a particular factor level (Table 7.5).



**Table 7.6 Marginal Analysis on the Quality Attributes of Flour in the Japanese Market**

|                    | Udon flour      |                      | Dry noodle flour |                      | Fresh Chinese noodle flour |                      | Ramen flour     |                      |
|--------------------|-----------------|----------------------|------------------|----------------------|----------------------------|----------------------|-----------------|----------------------|
| Factor /a, b, c    | Change in level | Marginal Probability | Change in level  | Marginal Probability | Change in level            | Marginal Probability | Change in level | Marginal Probability |
| <b>Ash content</b> |                 |                      |                  |                      |                            |                      |                 |                      |
|                    | 0.50% to 0.42%  | 0.15                 | 0.55% to 0.48%   | 0.05                 | 0.50% to 0.48%             | 0.12                 | 0.50% to 0.42%  | 0.22                 |
|                    | 0.42% to 0.38%  | 0.16                 | 0.48% to 0.42%   | 0.12                 | 0.48% to 0.42%             | 0.08                 | 0.42% to 0.38%  | 0.04                 |
|                    | 0.38% to 0.35%  | 0.15                 | 0.42% to 0.35%   | 0.26                 | 0.42% to 0.35%             | 0.23                 | 0.38% to 0.35%  | 0.12                 |
| <b>Color</b>       |                 |                      |                  |                      |                            |                      |                 |                      |
|                    | 89 to 91        | 0.17                 | 89 to 90         | 0.10                 | 89 to 90                   | 0.11                 | 89 to 91        | 0.08                 |
|                    | 91 to 93        | 0.03                 | 90 to 92         | 0.01                 | 90 to 92                   | -0.09                | 91 to 92        | 0.002                |
|                    | 93 to 95        | -0.09                | 92 to 93         | 0.002                | 92 to 93                   | 0.01                 | 92 to 94        | -0.005               |
| <b>Amylograph</b>  |                 |                      |                  |                      |                            |                      |                 |                      |
|                    | 250 to 300      | 0.17                 | 250 to 300       | 0.08                 | 250 to 300                 | 0.09                 | 250 to 300      | 0.18                 |
|                    | 300 to 400      | 0.11                 | 300 to 400       | 0.09                 | 300 to 400                 | 0.08                 | 300 to 400      | 0.10                 |
|                    | 400 to 500      | 0.19                 | 400 to 500       | 0.19                 | 400 to 500                 | 0.22                 | 400 to 500      | -0.03                |

/a Two predicted probabilities that use different values for a particular variable and that use the same set of values for the rest of the explanatory variables (*ceteris paribus*) are compared to derive the marginal probability of change in the level of a factor. The difference between these two predicted probabilities is interpreted as the marginal effect of the specific variable on the probability of miller's choice. To calculate predicted probabilities, a specified level of each of the explanatory variable needs to be determined for choice A and choice B. The factor levels that are identified from preferred product profiles are used as the base case (choice B).

/b Note that the factor level for the price variable is fixed at the level of "no change" for all calculations of the marginal probabilities.

/c note that marginal probabilities are derived from taking differences between total probabilities of choice A and choice B (Table 7.6 a).



**Table 7.6a Predicted Probabilities of Choices A and B for the Quality Attributes of Flour in the Japanese Market**

| Udon Flour      |                         |             | Dry noodle Flour |                         |             | Fresh Chinese noodle Flour |                         |             | Ramen Flour  |                         |             |
|-----------------|-------------------------|-------------|------------------|-------------------------|-------------|----------------------------|-------------------------|-------------|--------------|-------------------------|-------------|
| Factor Level /c | Predicted Probabilities |             | Factor Level     | Predicted Probabilities |             | Factor Level               | Predicted Probabilities |             | Factor Level | Predicted Probabilities |             |
| Ash content     | Choice A /a             | Choice B /b |                  | Choice A /a             | Choice B /b |                            | Choice A /a             | Choice B /b |              | Choice A /a             | Choice B /b |
| 0.50%           | 0.04                    | 0.91        | 0.55%            | 0.06                    | 0.87        | 0.50%                      | 0.05                    | 0.89        | 0.50%        | 0.06                    | 0.73        |
| 0.42%           | 0.19                    | 0.77        | 0.48%            | 0.11                    | 0.83        | 0.48%                      | 0.17                    | 0.78        | 0.42%        | 0.28                    | 0.57        |
| 0.38%           | 0.34                    | 0.63        | 0.42%            | 0.22                    | 0.72        | 0.42%                      | 0.25                    | 0.70        | 0.38%        | 0.32                    | 0.53        |
| 0.35%           | 0.49                    | 0.49        | 0.35%            | 0.48                    | 0.48        | 0.35%                      | 0.48                    | 0.48        | 0.35%        | 0.44                    | 0.44        |
| Color           |                         |             |                  |                         |             |                            |                         |             |              |                         |             |
| 89              | 0.28                    | 0.69        | 89               | 0.37                    | 0.59        | 89                         | 0.38                    | 0.59        | 90           | 0.36                    | 0.50        |
| 91              | 0.45                    | 0.52        | 90               | 0.47                    | 0.49        | 90                         | 0.48                    | 0.48        | 91           | 0.44                    | 0.44        |
| 93              | 0.49                    | 0.49        | 92               | 0.48                    | 0.48        | 92                         | 0.39                    | 0.57        | 92           | 0.44                    | 0.44        |
| 95              | 0.40                    | 0.57        | 93               | 0.48                    | 0.48        | 93                         | 0.41                    | 0.56        | 94           | 0.43                    | 0.44        |
| Amylograph      |                         |             |                  |                         |             |                            |                         |             |              |                         |             |
| 250             | 0.04                    | 0.91        | 250              | 0.12                    | 0.82        | 250                        | 0.10                    | 0.85        | 250          | 0.16                    | 0.66        |
| 300             | 0.18                    | 0.78        | 300              | 0.20                    | 0.75        | 300                        | 0.19                    | 0.76        | 300          | 0.34                    | 0.51        |
| 400             | 0.30                    | 0.67        | 400              | 0.29                    | 0.66        | 400                        | 0.27                    | 0.69        | 400          | 0.44                    | 0.44        |
| 500             | 0.49                    | 0.49        | 500              | 0.48                    | 0.48        | 500                        | 0.48                    | 0.48        | 500          | 0.41                    | 0.46        |

/a Predicted probabilities of choice A varies as the level of each factor changes, ceteris paribus.

/b The factor levels in choice B are held constant based on the definition of the preferred profile (Table 6.4). Therefore, predicted probabilities of choice B are used as the base.

/c The predicted probabilities of choice A are used to derive marginal probabilities of change in a particular factor level (Table 7.6).



**Table 7.7 Competitiveness of Three Export Nations**

|                 | South Korea                  | Japan                           |
|-----------------|------------------------------|---------------------------------|
| Hard Wheat      | N/A                          | Dark Northern Spring (DNS)      |
| Semi-hard Wheat | No Market Leader             | Hard Red Winter (HRW)           |
| Medium Wheat    | Australian 100% Noodle Wheat | Australian Standard White (ASW) |
| Soft Wheat      | Western White (WW)           | N/A                             |

**Table 7.8 Origin Preferences by Japanese and Korean Millers**

|                 | South Korea | Japan     |
|-----------------|-------------|-----------|
| Hard Wheat      | N/A         | the US    |
| Semi-hard Wheat | Australia   | Australia |
| Medium Wheat    | Australia   | Australia |
| Soft Wheat      | the US      | N/A       |

**Table 7.9 Actual Market Share of Three Exporting Nations (1996)**

|           | South Korea | Japan |
|-----------|-------------|-------|
| Australia | 29%         | 21%   |
| the US    | 68%         | 54%   |
| Canada    | 3%          | 25%   |



## 8. GENERAL DISCUSSION AND CONCLUSIONS

### 8.1 CONCLUSIONS AND DISCUSSION

Quality differences between wheat are a major competitive factor among wheat exporting nations. Wheat-importing nations demand imported wheat which is specific to such factors as prices, end-use characteristics of wheat, technical requirements of flour milling processes and trade-related interventions such as tariffs. The importance of quality differentiation as a source of competitive advantage among exporters depends on the particular requirements of different import markets. Analysis of import demand for wheat in a particular market requires highly specific data that examine the particular features of that market.

In this study, the noodle wheat market segments of Japan and South Korea are selected as the target market for analysis of the import demand for wheat. Two features of these markets explain the importance of the focus of this study. First, noodle markets in Japan and South Korea are growing importance. Second, regulation on wheat importation is expected to decrease in Japan. The milling sector in South Korea began to import wheat under an open system in 1990. A shift towards privatization of the wheat marketing system in Japan and the liberalization of Korean milling sector may intensify the competition in the flour milling industries in both markets. This may also change the nature of competition among wheat exporting nations. The Japan Food Agency (JFA) initiated a series of policy reforms in the wheat marketing system in 1998, suggesting that analysis is required to evaluate the implications of current and future reforms on market demand in Japan. The quality characteristics of wheat and flour for noodle processing are important to Japanese and Korean millers in making purchasing decisions about imported wheat. This study focuses on improving knowledge about these quality characteristics.

This thesis evaluates the demand for wheat and flour for the noodle market in Japan and South Korea using survey methods. Specifically, multinomial logit models (MNL) are developed for each market to examine the preferences of Japanese and Korean millers for quality characteristics of wheat and flour. Contrary to earlier studies that analyse import demand in international wheat markets using aggregate secondary data, this study developed and analysed primary data on millers' preferences for wheat and flour quality characteristics for the noodle markets in both Japan and South Korea. This objective is accomplished through the development and estimation of models of millers' choices of different wheat using data of stated preference methods (SPM) for both the Japanese and South Korean milling industries. In the evaluation of the Korean milling industry an alternate method of analysing preferences, called the semantic differential scale (SDS) method, is also employed to derive millers' preferences on wheat and flour quality.

The empirical approach of estimating SPM models is particularly attractive for a number of reasons. First, the estimated coefficients of the SPM models in each market could be used to generate the preferred profiles of Korean and Japanese millers for each wheat class and noodle flour product. The preferred product profiles are then compared with the wheat products that are currently marketed by the U.S., Canada and Australia into these markets. The comparison between the preferred profiles of product characteristics and the



characteristics of the currently marketed products are taken as reflective of the effectiveness and strength of each major exporter's sales efforts to South Korean and Japanese wheat markets. Information about the preferred product profiles could be used as a guideline for the wheat grading system and wheat-breeding program in exporting nations. Knowledge of preferred levels of factors in wheat and flour indicate which characteristics should be concentrated on and improved and the specific target levels of each factor. Second, the marginal effect of changes in levels of quality factors of wheat and flour on the probability of millers' purchase choices can be calculated based on the estimated coefficients of the SPM models. Marginal analysis of the quality factors of wheat and flour in each market allows a direct comparison of choice behavior of the Japanese and the Korean millers. Information on differences in the choice behavior of Japanese and Korean millers for wheat and flour can be used by exporting-nations in developing differentiated marketing programs for each markets.

In general, the results of the estimation of the SPM models show that millers in Japan and South Korea have differences in their preferences for selected quality factors of wheat and flour. WW from the U.S. closely meet the quality specifications of soft wheat that are preferred by Korean millers. It was found that 100% Australian noodle wheat is found to cater to the quality specification of medium wheat preferred by Korean millers. The results of the SDS analysis confirmed the SPM results on the Korean market. The results also indicate that wheat of ASW from Australia is competitive in the medium wheat market segment in Japan. DNS and HRW from the U.S. are found to be competitive in the hard and the semi-hard wheat market segments in Japan.

Millers in both Japan and South Korea revealed distinct preferences for origin for each wheat class. Overall, Australia appears to have a stronger brand image in both of the medium and the semi-hard wheat categories in Japan and South Korea than the U.S. and Canada. Australia currently does not supply semi-hard wheat which can closely meets the preferred quality profiles by Japanese and Korean millers. Nonetheless, the results evidently show that wheat of Australian origin is preferred to wheat of U.S and Canadian origin by millers in both nations. This implies that Australia has established successfully a positive brand image in the Japanese and Korean milling industries. Currently, the preferences of Australian origin by Japanese millers do not effectively translate into the actual market share of Australian wheat in Japan since millers have limited influence on the quality specifications of imports and sources in Japan. However, as the wheat marketing system gradually deregulates in Japan, it could be expected that millers' preference for wheat of Australian origin could be realized, resulting in increased market share of Australian wheat in Japan.

Overall, comparisons of choice behavior of Japanese and Korean millers through the marginal analysis of quality factors of wheat and flour suggest a number of important observations. First, Korean millers are more responsive than Japanese millers to changes in the levels of quality factors of wheat and flour. This implies that product development that can closely match the quality specifications of South Korean millers could result in greater response by Korean millers. Second, Korean millers are found to be more stringent in their quality specifications that they apply in purchasing wheat. Most notable



is the difference in the preferences for dockage level by Japanese and Korean millers. A level of dockage at 0.4 percent had a positive effect of probability on the probability of wheat purchase by Japanese millers, while this dockage level had negative effect on the probability of wheat choices by Korean millers. This suggests that wheat-exporting nations may consider applying differentiated regulations in setting the dockage level of wheat exported to Japan and South Korea.

The results discussed above can be used to deduce some important implications for the Canadian wheat industry. First, in general, Korean millers are more responsive than Japanese millers to quality improvement of wheat for noodle processing. Second, Korean millers are found to be more stringent in quality specification associated with the acceptance level of dockage. Canadian wheat generally has a lower level of dockage relative to wheat from U.S. and Australia. Canada could build on this strength in extending marketing efforts to the noodle wheat market in South Korea if other product characteristics can also be developed. The findings of the study suggest that wheat-exporting nations may need to develop differentiated programs of product development for wheat sales to Japan and South Korea. Results from the identification of preferred product profile of wheat and flour can be used to develop or refine quality specifications of Canadian wheat currently marketed to these nations.

More specifically, the semi-hard wheat market segment appears to have higher potential for Canadian wheat exporters. Two reasons can be noted for this suggestion. First, Canada is a major supplier of hard wheat with high protein content (i.e. CWRS 13.5%). If Canadian wheat exporters can develop an effective product development and marketing plan to provide semi-hard wheat that matches Korean millers' specifications of semi-hard wheat, Canada's market position in South Korea may improve significantly. Second, although semi-hard wheat of Australian origin was found to be preferred by Korean millers, Australia currently does not supply semi-hard wheat to South Korea that closely meets the preferred quality profiles. The U.S. also does not market semi-hard wheat to South Korea that satisfies Korean millers' preferences. Thus, there is no distinct market leader in the semi-hard wheat market segment in South Korea. This suggests that Canada has some potential of improving market position in this market segment. Korean millers also exhibit a preference for Canadian-origin wheat in the medium wheat class, relative to wheat of U.S. origin. Canada could build on its relative strength of brand image relative to the U.S. in this important wheat category if it can emphasize product development of medium wheat of desired characteristics for the South Korean market.

Finally, it is evident that Canada has a relatively weaker position than the U.S. and Australia in the noodle wheat market of Japan. Canada currently does not supply any wheat class that satisfies the quality specifications of preferred noodle wheat profiles, thus wheat of Canadian origin is dominated by wheat of U.S. and Australian origins. This implies that Canada may need to pursue extensive product development and marketing efforts to develop wheat products and establish a brand image. A proper composition of product development and marketing efforts could enable building a reputation for quality differentiation of Canadian wheat in the Japanese noodle wheat market. The scope of product differentiation of wheat marketed to Japan is constrained by the current system of



wheat marketing in Japan since Japanese millers have limited influence on the quality specifications for imported wheat. However, as the wheat marketing system gradually deregulates, it is anticipated that the competition among wheat-exporting nations may intensify. The implication of gradual deregulation in Japan is that Japanese millers' preferences on quality characteristics of imported wheat could effectively translate into changes in actual market demand. Canadian wheat exporters could emphasize the educational component of marketing programs such as through technical seminar to increase awareness of Japanese millers on specific quality characteristics of Canadian wheat which may potentially be used in milling noodle flour. Again, however, product development of wheat oriented to noodle uses will affect Canada's success in this market.

## **8.2 RECOMMENDATIONS RELATING TO FUTURE RESEARCH**

In this study, discrete choice models are used to estimate the effects of the quality attributes on millers' probabilities of wheat and wheat flour choices. Since the study focused on identifying preferences of noodle wheat and flour by Japanese and Korean millers, choice experiments were developed based on hypothetical scenarios. Although extensive pre-survey interviews were conducted to ensure that the hypothetical choice sets portrayed realistic range of factor levels, consistency of the SPM data with actual market behavior is a potential issue, since any inconsistency in the SPM data versus the actual market behavior might create potential bias. Adamowicz *et al.* (1994) suggest that the accuracy of SPM parameter estimates could be improved by combining SPM data with revealed preference (RP) data, which represents actual market behavior. Hence, RP data on Japanese and South Korean millers could be collected in future and combined with SPM data in future models of choice behavior.



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